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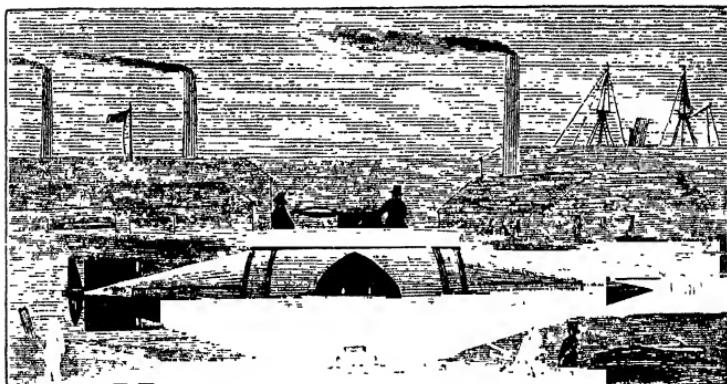
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THE
YEAR-BOOK OF FACTS
IN
SCIENCE AND THE USEFUL ARTS
FOR
1879-80.

EDITED BY
JAMES MASON.



THE GARRETT SUBMARINE TORPEDO BOAT.

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PREFACE.

THE YEAR-BOOK OF FACTS for 1879-80 contains, as in previous years, a collection of popular notes, obtained from various sources, relating to scientific progress.

Our object has never been to be exhaustive, and the specialist will see that we have ignored many things naturally regarded by him as of importance. What we have tried to do is to be interesting, and to select only those subjects on which the general public might be supposed to desire information.

In this we hope to have succeeded, and in laying our work before the reader, we feel much gratification at being the means of introducing to his notice so many valuable results obtained by the labours, during the past year, of the scientific workers of the world.

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THE YEAR-BOOK OF FACTS.

I.—THE HUMAN RACE.

Surgery and Superstition in Neolithic Times.—A paper by Miss A. W. Buckland on this subject was read at the meeting of the British Association. Its object was to show the frequent use of trepanning in Neolithic times, as proved by the late Dr. Broca ; to call attention to the proofs he has given of the fact, to his explanation of the reason of the practice, and to the superstitions associated with it, and its connection with the use of cranial amulets. Dr. Broca asserts that in Neolithic times a surgical operation was practised, which consisted in making an opening in the skull, chiefly of infants, in order to cure certain internal maladies, such as epilepsy, and convulsive disorders which in early times were confounded with epilepsy, and he maintained that such individuals as survived this operation were looked upon as endowed with peculiar properties of a mystic character, and when they died, rounds or fragments were frequently cut from the trepanned skulls to serve as amulets. Considering that this custom of trepanning still exists, according to among some of the South Sea Islanders, the Kabyles of Algiers, and the mountaineers of Montenegro, Miss Buckland suggested that greater attention should be directed to this curious subject by English antiquaries.

The Antiquity of Man.—Professor Mudge has presented some interesting evidence relating to the antiquity of man, in an American scientific journal. He starts by assuming the correctness of the generally accepted opinion among geologists that man was on the earth at the close of the Glacial epoch, and endeavours to prove that the antiquity of the race cannot be taken at less than 200,000 years. After the Glacial epoch, American geologists have recognised, by their effects, three others—namely, the Champlain, the Terrace, and the Delta, all supposed to be of nearly equal length. His argument for estimating the duration of these epochs is as follows :—

He takes the case of the Delta of the Mississippi, and notes the fact that for a distance of about 300 miles of this deposit there are to be observed buried forests of large trees, one over the other, with inter-spaces of sand. Ten distinct forest growths of this nature have been observed, which must have succeeded one another. These trees are the bald cypress of the Southern States. Some have been

observed over 25 feet in diameter, and one contained 5,700 annual rings. In some instances, these huge trees have grown over the stumps of others equally large, and such instances occur, in all, or nearly all, the ten forest beds.

From these facts, Professor Mudge thinks it is not assuming too much to estimate the antiquity of each of these forest growths at 10,000 years, or 100,000 years for the ten forests. This estimate would not take into account the interval of time—which doubtless was very considerable—that elapsed between the ending of one forest and the beginning of another.

Such evidence would be received in any court of law as sound and satisfactory. We do not see how such proof is to be discarded when applied to the antiquity of our race. There is satisfactory evidence that man lived in the Champlain epoch. But the Terrace epoch, or the greater part of it, intervenes between the Champlain and Delta epochs, thus adding to my 100,000 years. If only as much time is given to both these epochs as to the Delta epoch, 200,000 years is the total result.

The Crania of Bushmen.—A paper on "The Crania of Bushmen" was read before the British Association by Prof. Rolleston. Having had six skulls brought to him from a spot where a tribe of Bushmen had been massacred by Kaffirs, he had carefully considered their formation and characteristics. The result of his examination was the conviction that they belonged to a race which had claims to a higher intellectual reputation than they usually obtained. He attributed the smallness of their intellectual development to its want of exercise. They were a people who had no competitive examinations, and no British Association to stimulate their intellectual faculties, or to

enlarge their brain power. If proof were wanted that such a course would produce such results, he suggested that the heads of the President and others on the platform who had had those advantages should be measured, and that someone should go outside and measure half a dozen heads in the street. The learned Professor dwelt at some length on the measurement of skulls and on the value of craniology if taken in connection with a consideration of all the other parts of a skeleton.

Great Toes in Annam.—Mr. Tremlett, the British Consul at Saigon, in his report for 1879, mentions as a remarkable peculiarity of the natives of the country, that they have the great toe of each foot separated from the others, like the thumb of the hand, and it can be used in much the same manner, though not to the same extent. This distinctive mark of an Annamite is not, however, usually seen in the vicinity of Saigon, but is now confined to the inhabitants of the more northern section of the empire, where the race has remained more distinct. This peculiarity is the meaning of the native name for the Annamite race; and that the name and peculiarity are of great antiquity is shown by their mention in Chinese annals, 2,300 B.C., as that (or those) of one of the "four barbarian" tribes that then formed the boundaries of the Chinese Empire.

Population of the World.—The population of the world now reaches 1,455,923,500 souls, according to the latest calculations of the German statisticians, Behm and Wagner, who publish "about

every two years an account of the area and population of the globe. Since their last issue, in 1878, the earth claims 16,778,000 additional inhabitants. In Europe dwell 315,929,000 persons; in Asia, 834,707,000; in Africa, 205,679,000; in America, 95,495,500; in Australia and Polynesia, 4,031,000; and in the Polar Regions 82,000. Coming to countries, we find that Great Britain and Ireland in 1879 possessed 34,517,000 inhabitants.

Statistics of the Human Race. — The number of languages spoken in the known world is 2,523, of which there are 587 in Europe, 396 in Asia, 376 in Africa, and 1,264 in America. The inhabitants of the globe profess 1,000 different religions. The number of men is nearly equal to that of women. A fourth of the children die before having reached the age of seven years; and a half before the seventeenth year. In 1,000 persons there is one centenarian; in 100 individuals there are six sexagenarians; in 500 there is one octogenarian. The earth is peopled by about a milliard of inhabitants. Every year 333 millions die, every minute 60, or 1 per second. These deaths are nearly balanced by the number of births.

A Primitive Community. — The smallest Protestant commune in Switzerland, probably in Europe, and certainly the most primitive, is that of Abländchenen, in the circle of Saanen, canton Berne. Abländchenen, a word literally signifying "a little out-lying place," is situated in a remote mountain valley, 4,000 ft. above the level of the sea, and its

unsophisticated inhabitants contrive to dispense with most of the appendages which are considered inseparable from modern civilization. Sir Wilfrid Lawson will be pleased to learn that they do not possess a single public-house; Dr. Richardson might possibly find in Abländchenen the Hygeia after which he sighs; for albeit there is not a doctor in the village, there has not been a death for many years; and were Mr. Bright to take up his abode there he would be freed from a trouble of which he has more than once feelingly complained, as, though the commune enjoys the blessings of a penny post, it has only one delivery of letters a-week. As may be supposed in these circumstances, daily papers do not command a very ready sale in the neighbourhood. Commerce and handicrafts are conspicuous by their absence; there is neither blacksmith, baker, wheelwright, nor shopkeeper in all the commune; and the people being all honest and peaceable, they require neither notary, lawyer, nor policeman. Every 14 days a pedlar with a van goes the round of the commune and supplies the housewives with all they want in the shape of crockery, drapery, thread, needles, paper, and sundries; food is provided by their own flocks, herds, and poultry, and it is hardly necessary to say, as they have little need for ready money, the Abländcheners keep no banker. They have a tiny church with a single bell, and it is a standing joke in the place that when a girl is born they ring a peal, but on the birth of a lad they ring only one bell. It may be supposed,

observed over 25 feet in diameter, and one contained 5,700 annual rings. In some instances, these huge trees have grown over the stumps of others equally large, and such instances occur, in all, or nearly all, the ten forest beds.

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perhaps, that the inhabitants of this sequestered valley find their lives somewhat hard and monotonous, but a correspondent writing thence to a Zurich paper says this is so far from being the case that they enjoy a far larger measure of happiness than falls to the lot of most men, and have no desire to exchange their Alpine home for the life of cities.—*Times*.

Extinct Tribes in South Africa.—At a meeting of the Anthropological Institute, in February, 1880, Dr. Emil Holub, the Austrian traveller, delivered a lecture on the Central South African Tribes, from the South Coast to the river Zambesi. The most novel portion of the lecture was the mention of his having found along the South African coasts clear traces of extinct tribes, who, judging from the rude shell-heaps and remains of the burnt bones of animals which they have left behind them, as well as from other indications, must have been very rude types of humanity indeed. Passing further into the interior, there were evident relics of quite a different stage of culture, of which there were no longer any vestiges to be seen among the natives, and he was at once reminded of the great African empire of Monomatapa, as it was called on the old Portuguese maps. There were workings of ancient mines, some even of gold, and the ruins of a rude kind of cyclopean fortifications. Such evidences pointed to exterminated tribes, testifying to the antiquity of the savage African rule of warfare, which exterminates all the males and allot

the wives and children to the victors as slaves.

The Industrial Population of France.—According to the *Annuaire Statistique* published in January, 1880, by the French Minister of Agriculture and Commerce, the total population of France, a little under 37 millions in round numbers, is divided into 12 million inhabitants of towns and 25 million inhabitants of the country. On eliminating from the general total 860,590 individuals (who are soldiers, sailors, students in schools, infirm and diseased, prisoners, or monks not giving instruction), the total of a little over 36 millions of persons participating fully in social life comprises, with regard to means of existence and professions, 210,200 persons without known professions; 71,300 vagabonds and mendicants; 2,151,900 stockholders (including 195,000 pensioners of the Government); 1,531,400 persons exercising liberal professions or living by them; 3,837,200 persons engaged in trade, transport and navigation, or living on their products; 9,274,500 persons engaged in various industries or living by them (6,000,000 in small industries, 3,000,000 in mining and manufactures); 18,968,600 persons practising agriculture or living by it (of whom 10½ millions are proprietors of their land, nearly six millions are tenant farmers, 2½ millions are agricultural specialists, comprising vine-growers).

On entering into detail of each of the great branches of the national production, it is found that 4,000,000 of proprietors or

agricultural tenants (of whom 400,000 are women) employ—as clerks, 82,000 men and 54,000 women; as workpeople, 590,000 men and 378,000 women; as day labourers, 922,000 men and 704,000 women; as domestics, 661,000 men and 663,000 women; and, on the other hand, that the families maintained by the landed property or agricultural work consist of 3,800,000 persons of masculine sex, and 7,200,000 of feminine; 1,125,000 industrial patrons (of whom 226,000 are women) have for clerks 143,000 men and 50,000 women; 1,555,000 workmen and 1,000,000 work-women; 305,000 male day labourers and 244,000 female; 78,000 male domestics and 143,000 female. The families living by industrial operations embrace nearly 1,600,000 persons of masculine sex and 3,000,000 of feminine; 784,000 employers in trade and carriage (of whom 221,000 are women) have 247,000 male *employés* and 71,000 female; 198,000 workmen and 56,000 workwomen; 140,000 male day labourers and 80,000 female; 65,000 male domestics and 188,000 cooks or nursery maids. They support families amounting to 661,000 boys and 1,346,000 girls.

Compression of the Feet of Chinese Women.—An American missionary, Miss Norwood, of Swatow, has lately described how the size of the foot is reduced in Chinese women. The binding of the feet is not begun till the child has learnt to walk and do various things. The bandages are specially manufactured, and are about two inches wide and two yards long for the first year, five yards long for

subsequent years. The end of the strip is laid on the inside of the foot at the instep, then carried over the toes, under the foot and round the heel, the toes being thus drawn towards and over the sole, while a bulge is produced on the instep and a deep indentation in the sole. The indentation, it is considered, should measure about an inch-and-a-half from the part of the foot that rests on the ground up to the instep. Successive layers of bandages are used till the strip is all used, and the end is then sewn tightly down. The foot is so squeezed upward that, in walking, only the ball of the great toe touches the ground. Large quantities of powdered alum are used to prevent ulceration and lessen the offensive odour. After a month the foot is put in hot water to soak some time; then the bandage is carefully unwound, much dead cuticle coming off with it. Ulcers and other sores are often found on the foot; frequently, too, a large piece of flesh sloughs off the sole, and one or two toes may even drop off, in which case the woman feels afterwards repaid by having smaller and more delicate feet. Each time the bandage is taken off the foot is kneaded, to make the joints more flexible, and it is then bound up again as quickly as possible with a fresh bandage, which is drawn up more tightly. During the first year the pain is so intense that the sufferer can do nothing, and for about two years the foot aches continually, and is the seat of a pain which is like the prickling of sharp needles. With continued rigorous binding, the foot

in two years becomes dead and ceases to ache, and the whole leg, from the knee downward, becomes shrunk, so as to be little more than skin and bone. When once formed, the "golden lily," as the Chinese lady calls her delicate little foot, can never recover its original shape.

Indian Graves in America.—An extensive burial-ground of the Lenni Lenape, or Delaware Indians, has recently been examined by one of the scientific societies of Pennsylvania. The cemetery was located on the north bank of the historical Brandywine Creek, on a prominence overlooking the valley. About twenty graves were opened with the following results:—The skeletons were stretched at full length with the heads towards the east. The depth of the graves was about three feet. Associated with the bodies were quantities of Venetian beads of various sizes, shapes, and colours, and a number of objects of Indian workmanship, such as arrow-heads and bead ornaments of stone.

In two of the graves were found several antique clay pipes of considerable interest, with the initials "R. T." stamped in the bowls. In the beginning and middle of the 17th century pipes were made by various makers in the vicinity of Bath, England. Among these was one Richard Tyler, and the initials "R. T." in all probability were impressed at his manufactory. An approximate date can, therefore, be assigned to these objects with some degree of certainty. The earlier British pipes, sometimes called

elfin or fairy pipes, and by some antiquaries attributed to the Romans, made, however, in the reign of Queen Elizabeth, frequently possessed the initials of the makers' names on the bases of the flat spurs which characterized them. These were gradually superseded by pipes with elongated bowls, in which the spurs or heels were pointed or entirely absent. The more recent English pipes of the last century, or thereabouts, had the names of their makers stamped on the stems. The examples referred to are of the elongated pattern, minus the heel, with the initials stamped in the bowls. The stems have been broken off about six inches from the bowls, having been originally longer. They were taken to America by the early settlers, and traded to the Indians.

These graves, while only perhaps a century or so in age, are particularly valuable to the student of American ethnology as producing skeletons of the tribe inhabiting the valley of the Delaware River at the time of the settlement of the States. Such remains have been exceedingly rare in Pennsylvania, and no graves have as yet been opened which did not produce objects of European introduction.

The Burial Customs of Fiji.—A paper on this subject, by the Rev. L. Fison, was read before the Anthropological Institute, on the 12th of April, 1880. There is no uniformity of custom in Fiji, so that no description of what is done by any one tribe can be taken as applicable to all the others. The strangling of widows, however,

that they might be buried with their dead husbands, seems to have been everywhere practised. The widow's brother performs the operation, and is thenceforward treated with marked respect by his brother-in-law's kinsfolk, who present him with a piece of land, over which the strangling cord is hung up. Should he, however, fail to strangle his sister, he is despised. When a woman is about to be strangled, she is made to kneel down, and the cord (a strip of native cloth) is put round her neck. She is then told to expel her breath as long as possible, and when she can endure no longer, to stretch out her hand as a signal, whereupon the cord is tightened, and soon all is over. It is believed that if this direction be followed insensibility ensues immediately on the tightening of the cord, whereas if inhalation has taken place there is an interval of suffering.

According to Fijian belief, at a certain place on the road to Mbulu (Hades) there lies in wait a god called Nangga-nangga, who is utterly implacable towards the ghosts of the unmarried, and he classes as bachelors all male ghosts who come to him unaccompanied by their wives. He lifts them above his head, and breaks them in two by dashing them down on a projecting rock. If the wife die before her husband, the widower cuts off his beard, and puts it under her left armpit. This serves as her certificate of marriage; and, on her producing it to Nangga-nangga, he allows her to pass.

On the island of Vanua Levu a noted "brave" is distinguished

from the common herd after death by being buried with his right arm projecting above the grave-mound, and passers-by exclaim with admiration as they look upon the fleshless arm, "Oh, the hand that was the slayer of men!" By many tribes the burial-place of their chief is kept a profound secret, lest those whom he injured during his life should revenge themselves by digging up and insulting, or even eating his body. Cave burial is common, although by no means universal; in some cases artificial caves are made.

On the death of the king of the Nakelo tribe three old men come, with fans in their hands, and conduct the spirit to the banks of the river. Here they call upon Themba—the Nakelo Charon—to bring over his canoe, and wait until they see a wave rolling in towards the shore, which they say is caused by the approach of the invisible canoe; they then avert their faces, point their fans suddenly to the river, cry aloud, "Go on board, sir," and forthwith run for their lives, for no eye of living man may look upon the embarkation. The grave is dug about hip deep, the body laid in it, and an old cocoa-nut is broken by a blow with a stone, being so held that the milk runs down upon the head of the corpse. The meat of the nut is then eaten by the three elders, and the grave is filled up.

Decrease of French Population.—The observations of statisticians have been of late directed to the serious but steady decrease in the population of France, as evinced by the gradual lessening of the birth-rate. In 1878 the number of births was 937,211, a

in two years becomes dead and ceases to ache, and the whole leg, from the knee downward, becomes shrunk, so as to be little more than skin and bone. When once formed, the "golden lily," as the Chinese lady calls her delicate little foot, can never recover its original shape.

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On the death of the king of the Nakelo tribe three old men come, with fans in their hands, and conduct the spirit to the banks of the river. Here they call upon Themba—the Nakelo Charon—to bring over his canoe, and wait until they see a wave rolling in towards the shore, which they say is caused by the approach of the invisible canoe; they then avert their faces, point their fans suddenly to the river, cry aloud, "Go on board, sir," and forthwith run for their lives, for no eye of living man may look upon the embarkation. The grave is dug about hip deep, the body laid in it, and an old cocoa-nut is broken by a blow with a stone, being so held that the milk runs down upon the head of the corpse. The meat of the nut is then eaten by the three elders, and the grave is filled up.

Decrease of French Population.—The observations of statisticians have been of late directed to the serious but steady decrease in the population of France, as evinced by the gradual lessening of the birth-rate. In 1878 the number of births was 937,211, a

lower average than that of the last four years. In 1861 the average was 2·69 per cent.; in 1862 it was 2·65; in 1863 it rose again to 2·69; but between 1864 and 1868 it sunk to 2·63. From 1874 to 1878 it further declined to 2·56, and in the latter year it was only 2·53. There are two causes for this decrease—viz., the fewer number of marriages, and, what is far more important, a great decline in the number of children resulting from these marriages. In the period between 1864 and 1868 the average of marriages was 0·79 per cent., which declined in the corresponding years of the next decade to 0·78, and is now only at the rate of 0·75. The following table shows how seriously the numbers of children born in wedlock have decreased :—

Period.	Per Cent.
1800 to 1815 ..	3·93
1816 .. 1830 ..	3·73
1831 .. 1835 ..	3·48
1836 .. 1840 ..	3·25
1841 .. 1845 ..	3·21
1846 .. 1850 ..	3·11
1851 .. 1855 ..	3·10
1856 .. 1860 ..	3·03
1860 .. 1865 ..	3·08

The proportion of children to each marriage is dwindling more and more, with the exception of Brittany and some of the departments in the centre and south, where the agricultural population is under the system of *métayage* or co-operative farming. In the class composed of petty tradesmen or the well-to-do peasants, there is seldom more than one child per marriage; and M. Baurillart has stated that in one of the rural communes in Picardy, he ascertained the number of children among the best-off of the peasants

to be 37 for 35 families. The illegitimate births in 1878 numbered 67,912, being 1,000 over and above that of the preceding year; but, notwithstanding this increase, the proportion for a term of years shows a rather tolerably stationary average. For instance, it was 7·28 in the period between 1851 and 1856; from 1856 to 1866 it rose to 7·56, and to 7·61 between 1864 and 1868. Between 1874 and 1878 it declined to 7·11, and rose again to 7·25 in 1878. To a certain extent the decrease in population is kept in check by the decrease in the mortality, which numbered 839,036 in 1878, or 2·26 per cent., whereas in 1864-8 it was 2·34. Another cause which affects it slightly, is the steady influx of foreigners into France, now estimated at one million, principally consisting of Belgians, Germans, Swiss, and Italians. The main difficulty, however, remains—what is to be the ultimate destiny of France if this decline of the population keeps on increasing?

Indian Mental Powers.—“A remarkable demonstration,” says Professor Monier Williams, writing to the *Athenaeum* in February, 1880, “has recently taken place at Bombay. A number of educated natives in high position have been seized by a kind of panic on suddenly waking up to the fact that orthodox Brahmanism, or, as they term it, the Aryan religion, is decaying and disappearing. This they attribute to the decline of Sanskrit learning consequent on the decline of nationality and patriotism among the native princes.

"They have accordingly resolved to unite in a common effort for the revival of Sanskrit lore and for a diffusion of a true knowledge of the Hindu religion. The movement has been inaugurated in rather a singular manner. A monster meeting has been held at Bombay in honour of a blind Pandit named Gattu-Lalaji. Addresses have been delivered in his praise, and a sum of 18,310 rupees presented to him as a reward for his zeal in the cause of religion, his success 'in purifying men's minds,' and his 'attractive genius for making extempore poems' (*sighra-kavita-sakti*.)

"Pandit Gattu-Lalaji was born at Kotah, in 1845, while his parents were on a pilgrimage. He lost the sight of both eyes, through small-pox, at the age of eight. He is chiefly celebrated for his power of composing impromptu Sanskrit verses, in which no Italian *improvvisor* has ever displayed equal talent.

"During one of my visits to Bombay he called on me, accompanied by three amanuenses, and requested a trial of his powers, declaring himself capable of composing six sets of extemporaneous verses simultaneously, on any six subjects and in any six metres I liked to select. I proposed three subjects — a description of Bombay, the advantage of Sanskrit learning, and the advent of the Prince of Wales to India — naming at the same time three of the most difficult metres I could remember. Without a moment's delay the Pandit dictated the required verses to his scribes with wonder-

ful precision and rapidity. He also conversed fluently in Sanskrit, and impressed me very favourably with his finished scholarship and the extent of his literary acquirements. Impromptu versifiers of this kind are called *Sighra-Kavis* or *Asu-Kavis*.

"The blind Pandit's successful *tour de force* in my presence was doubtless more due to great powers of memory than to poetical genius. A Hindu's capacity for keeping a number of different subjects in his recollection at one time, and yet abstracting his mind so as to concentrate his attention on each one separately and consecutively, is surprising. In this respect he far outdoes Europeans. While I was travelling in the south of India I was visited by a *Satavadhani*, that is to say, a man who could attend to one hundred things at once. He could play several games of chess, write and repeat poetry, work out problems, and make calculations of all kinds simultaneously. I also heard of a *Trinsadavadhani*, or man who could attend to thirty subjects.

"*Ashtavadhanis*, or persons capable of attending to eight subjects simultaneously, are by no means uncommon throughout all parts of India. A man whose powers of attention are of this more limited calibre employs his skill by asking eight persons, entire strangers to himself, who speak eight different dialects, to repeat the first word of eight different sentences, and then the second, and so on consecutively, till every word of the eight sentences has been repeated. Thereupon, without a moment's

hesitation, the Ashtavadhani reproduces all the eight sentences, separately and continuously, with each word in proper order, though the utterance of each has been interrupted by the interpolation of seven other words in different languages."

The People of Wales.—In the department of Anthropology, at the meeting of the British Association, the address was delivered by one of the vice-presidents of the section, Mr. F. W. Rudler, F.G.S., who began by stating that to the student of anthropology it was always refreshing to visit a province of the United Kingdom in which the inhabitants still retained, in large measure, their peculiarities of language and of race. But in that part of the Principality they were now visiting, these characteristics had, for many generations, been growing fainter and fainter. In fact, the local circumstances which rendered a meeting of the British Association possible, were precisely those which tended to obliterate ethnical distinctions. The material prosperity of any locality naturally draws towards it a stream of immigration from less prosperous districts, and thus produces an artificial mixture of population. If the influx into Swansea had come only from the agricultural parts of Wales, there would have been comparatively little ethnical confusion; but, as a matter of fact, all the large towns of Glamorganshire, such as Swansea, Cardiff, and Merthyr, have received strong accessions to their population from various parts of England and of Ireland. The

anthropologist would, therefore, be ill-advised if he resorted to any of these flourishing centres for the purpose of studying the typical Welshman.

Glamorganshire probably contains, at the present time, more than one-third of the entire population of Wales; yet the area of the county is but little more than one-ninth of the total area of the Principality. This concentration of the people is due, directly or indirectly, to the gigantic development of those mining and metallurgical industries which are centred in this county. The temptation of high wages, offered in seasons of prosperity, has attracted hither a large number of settlers from different parts of the United Kingdom. Occasionally, too, recourse has been had to the technical skill of foreigners; and thus ethnical elements have been introduced, to a limited extent, from outside the British Isles. It is worth while noting that the movement of population towards South Wales has been mainly determined by the geological structure of the district. It was the occurrence of coal that originally tempted Ulricke Frosse to bring his cargo of copper ore across from Cornwall to be smelted in the Vale of Neath; and it is still the working of coal which maintains the local industries, and supports the vast population of Glamorganshire. The connection between the geological structure of a district and the social and ethnic characteristics of its inhabitants has been recognised by no one more clearly than by the distinguished geo-

logist who presides over the present meeting of this Association.

Apart, however, from all foreign admixture, there is still in Glamorganshire, especially in the outlying districts, a very large proportion of the population who may be regarded as typically Welsh. If we can strip off all extraneous elements which have been introduced by the modern settler and the mediæval Fleming, possibly also by the Norman baron and even the Roman soldier, we may eventually lay bare for anthropological study the deep-lying stratum of the population—the original Welsh element. The researches of archaeological anatomists tend to prove that this country was tenanted in ante-historic, or pre-Roman times, by two peoples, who were ethnically distinct from each other. It is difficult to resist the temptation of applying this to the ethnology of Wales. According to the view advocated by Thurnam, we have a right to anticipate that the oldest skulls found in this country would be of dolichocephalous type, and such I believe to be actually the case. Setting aside any archaeological evidence derived from the bone-caves, barrows, or other sepulchres in Wales, we may finally look at the outcome of our enquiry into Welsh ethnology.

If we admit, as it seems to me we are bound to admit, the existence of two distinct ethnical elements in the Welsh population, one of which is short, dark, and dolichocephalic—call it Silurian, Atlantean, Iberian, Basque, or what you will; and the other of

which is tall, fair, and brachycephalic, such as some term Cymric, and others Ligurian; then it follows that by crossing of these two races we may obtain not only individuals of intermediate character, but occasionally more complex combinations; for example, an individual may have the short stature and long head of the one race associated with the lighter hair of the other; or, again, the tall stature of one may be found in association with the melanism and dolichocephalism of the other race. It is, therefore, no objection to the views herein expressed if we can point to the living Welshman who happens to be at once tall and dark, or to another who is short and fair. At the same time, I am by no means disposed to admit that when we have recognised the union of the xanthous and melanic elements in Wales, with a predominance of the latter in the south, we have approached to anything like the exhausting limit of the subject. Still earlier races may have dwelt in the land, and have contributed something to the composition of the Welsh.

The roots of the Welsh may reach far down into some hidden primitive stock, older, mayhap, than the Neolithic ancestors of the Silurians; but of such pristine people we have no direct evidence. So far, however, as positive investigation has gone, we may safely conclude that the Welsh are the representatives, in large proportion, of a very ancient race or races; and that they are a composite people, who may perhaps be best defined as *Siluro-Cymric*.

II.—THE WORLD OF PLANTS AND ANIMALS.

An Enemy in the Field.—Great mischief has recently been done in Russia by insects. One of the most destructive insects in South Russia is the beetle called by naturalists *Anisoplia Austrica*, and by the rural population of Kherson *Couzka*. This insect first appeared in 1865 in the Melitopol district, but there is nothing known as to how and whence it came, as it had never been heard of in any other part of Russia or the bordering countries. The form of the insect is oblong and slightly convex; it is of the size of a grain of ricinous seed and of a cinnamon colour. The change from egg to larva and from larva to a full-grown beetle takes nearly two years. The female lays her eggs about two inches deep in the earth, and the worms, after leaving the eggs, grow very slowly, live the whole winter in the earth, finding nourishment in the soil, and then become more developed, but remain as worms the following summer and winter; then on the approach of spring they rise to the surface of the ground, where they accumulate. As many as ten bushels of the beetles have been collected from one acre of wheat. They fly from ear to ear and do not quit it until it is destroyed. They are capable of making long flights from one government to another. Last

summer a mass of these beetles was discovered in the sea near Ochakoff; they were so thick that it was difficult to pull a boat through them. They were gradually washed on shore, and the people, instead of taking prompt measures, allowed them to remain there. When at last they recognised the danger with which they were menaced, persons were sent with horses, casks, &c., to destroy them, but it was too late; about three-fourths had recovered strength and flown into the neighbourhood to form a new generation in that district. The British Vice-Consul at Nicolaieff reports that unless efficient measures are adopted it is probable that all agricultural Russia will eventually become the prey of these insects, causing privations hitherto little known in the country. He considers that the subject demands the serious attention of Europe, as Russia supplies so many countries with wheat, and her misfortune may raise the price of American produce.

The Colour of Flowers.—At a recent meeting of the Vaudois Society of Natural Sciences, Professor Schnetzler read an interesting paper on the colour of flowers. It has been generally supposed that the various colours observed in plants were due to so many different matters, each colour being a different chemical combination

without relation to the others. Now Professor Schnetzler shows by experiments that when the colour of a flower has been isolated, by putting it in spirits of wine, one may, by adding an acid or alkaline substance, obtain all the colours which plants present. Flowers of peony, e.g., give, when placed in alcohol, a red-violet liquid. If some salt of sorrel be added, the liquid becomes pure red; while soda changes it, according to the quantity, into violet, blue, or green. In this latter case the green liquid appears red by transmitted light, just as does chlorophyll (the green colouring matter of leaves). The sepals of peony, which are green with a red border, become wholly red when put in salt of sorrel. These changes of colour, which can be had at will, may quite well be produced in the plant by the same causes, for in all plants there are always acid or alkaline matters. Further, it is certain that the transformation from green into red, observed in the leaves of many plants in autumn, is due to the action of tannin, which they contain with chlorophyll. Thus, without wishing to affirm it absolutely, Professor Schnetzler supposes *a priori* that there is in plants only one colouring matter—chlorophyll—which, being modified by certain agents, furnishes all the tints which flowers and leaves present. As to white flowers, it has been found that their coloration is due to air contained in the cells of the petals. On placing the latter under the receiver of an air-pump, they are seen to lose their colour and become transparent as the air escapes from them.—*Times.*

English Birds Compared with American.—Under this heading, in the *American Naturalist*, Mr. H. D. Minot gives the results of his observations during a lengthened stay in England in 1879. Mr. Minot has no hesitation in saying that birds are less abundant in England than in America. On the other hand, in spite of extensive wild lands, their companionship is more readily obtained, and the naturalist need not seek for birds so often in England as in America; the respect and consideration shown them here, give some of them, at times, almost a social ease with man. Putting schoolboys and bird-catchers out of count, the public at large are more reasonable in their instincts and customs than the free and thoughtless American, who must fire his gun whenever he gets a chance, regardless of all true interests concerned. Among a people notorious for their love of sport, Mr. Minot thinks this sensible respect for law and nature is of the highest value. Wild pigeons, though heavier than those of America, have more than a correspondingly slower flight; and it is curious to observe, according to Mr. Minot, how heavy the English atmosphere seems to English birds, and how general it makes this difference in speed. The European swift he finds much less quick and dashing than his American cousin, and the grouse no test for the sportsman's skill as compared with American game birds. Mr. Minot remarks, by the way, that the moors of Derbyshire were the only place in England in which he met with mosquitos. Is the American naturalist's obser-

vation not here at fault? On the whole, however, he thinks there is a comparative want both of cheerful and annoying insect life here. He generally found the walking bad and the air neither exhilarating nor soothing. Freedom from enervating heat was "offset" by subjection to depressing wet.

The birds of England are inferior to those of America, not only in variety, but in colouring and song. "Her kingfisher may be tropical in brilliancy as our humming bird; her thrushes, swallows, and finches as pretty as any of their tribes, but with the exquisite and delicate beauty of our wood-warblers, and with the splendours of our tanagers, orioles, and starlings, she has almost nothing among her familiar friends to compare." Among song birds, we have none to compare to the American hermit thrush, house wren, water-warbler, solitary vireo, song sparrow, or rose-breasted grosbeak. In short, for song birds, England, in Mr. Minot's opinion, is not to be compared to America. Although Mr. Minot heard the nightingale only one evening in the end of May, under the most unfavourable conditions as to weather, interruptions, and other conditions, "he estimated that the nightingale had a most wonderful compass, and was the greatest of all bird vocalists, but with a less individual and exquisite genius than our wood-thrush. Yet, to hear that delicious, soft, liquid, warbled trill, which she alone can give, was a lasting pleasure."

Of the skylark, Mr. Minot says his flight is indeed astonishing,

though exaggerated by report; half a mile, he thinks, was full the greatest height he reached. His song Mr. Minot characterises as an unbroken, ecstatic torrent; but it is shrill, slightly harsh, and not very musical. It is not so rich as the American bobolink's roundelay; and its sweetest notes, though they suggest, do not equal the canary's song, except for their intensity of utterance. All his poetry and the secret of his charm is in his flight. Mr. Minot was much more fascinated with the woodlark, whose song was the only new type of bird song he heard when abroad. The song thrush also stands high in his estimation, and also the blackbird. The wren sings with sweetness and power; the black-cap's song is sweet, joyous, and varied, the chaffinch tiresome.

The Swimming Bladder of Fishes.—In a recent note to the Paris Academy, Professor Marangoni gives the results he has arrived at in a study on the swimming bladder. He states, first, that it is the organ which regulates the migration of fishes, those fishes that are without it not migrating from bottoms of little depth, where they find tepid water; while fishes which have a bladder are such as live in deep, cold water, and migrate to deposit their ova in warmer water near the surface. Next, fishes do not rise like the Cartesian diver (in the well-known experiment), and they have to counteract the influence of their swimming bladder with their fins. If some small dead and living fishes be put into a vessel three-quarters full of water, and the air be compressed, or rarefied, one

finds in the former case the dead fish descend, while the living ones rise, head in advance, to the surface. Rarefying has the opposite effect. Fishes have reason to fear the passive influences due to hydrostatic pressure ; when fished from a great depth, their bladder is often found to be ruptured. Thirdly, the swimming bladder produces in fishes a two-fold instability—one of the level, the other of position. A fish having once adapted its bladder to live at a certain depth, may, through the slightest variation of pressure, be either forced downwards or upwards, and thus they are in unstable equilibrium as to level. As to position, the bladder being in the ventral region, the centre of gravity is above the centre of pressure, so that fishes are always threatened with inversion ; and, indeed, they take the inverted position when dead or dying. This double instability forces fishes to a continual gymnastic movement, and doubtless helps to render them strong and agile. The most agile of terrestrial animals are also those which have least stability.

The Australian Eucalyptus.—The various species of the genus *Eucalyptus* are principally distributed over the whole Australian continent and Tasmania ; a few even extend to the Indian islands. They are of immense importance to our colonists, and the Government of West Australia has enabled Baron von Mueller, the Government botanist for the colony of Victoria, to publish two decades of a beautifully illustrated quarto work which is to be wholly devoted to descriptions of the

species of this genus. These eucalypts form the principal timber vegetation of the wide Australian continent, and for many ages the inhabitants of that portion of the globe will have to rely largely, if not mainly on them for their wood supply. These trees are known in Australia under very many local names, such as gum-trees, stringy-bark trees, iron-trees, &c. Some of them are low-growing shrubs, others attain to immense heights. Thus the spotted gum-tree of Victoria (*Eucalyptus goniocalyx*) attains in rich forest valleys a height of 300ft., with a stem diameter not rarely up to 6ft., exceptionally even of 10ft. Its wood is hard and tough, varies from a pale yellowish to a brownish colour, and is exceedingly durable, lasting long underground. It is in great demand. Another species, the ordinary stringy-bark tree of Victoria (*E. macrorhyncha*), has very hard wood, which is covered with a thick fibrous bark which is persistent on branches and stem, and can be removed in large sheets. These, when flattened and dried under pressure, are extensively used for roofing purposes, and such roofs have been known to last for 20 years. Another species, the yellow-box tree (*E. melliodora*), yields a good wood, and, in addition, one ton weight of its freshly gathered branches and leaves will yield, on proper treatment, 2lb. 12oz. of potash, and of crude pearlash a much larger quantity.

The useful products to be obtained from these trees are very numerous, and include, in addition to the timber and potash just

alluded to, oils, tars, acids, dyes, and tans; so useful are they that we trust proper measures will be taken by the various local Governments in Australia so as to avoid some present need causing their destruction before others can be planted to fill the places of those cut down. We hope with the author that the importance of these eucalypts, whether viewed in their often unparalleled celerity of growth among hard-wooded trees, or estimated in their manifold applicabilities to the purposes of industrial life, or contemplated as representing among them in all-towering height the loftiest trees in Her Majesty's dominions, will be still more deservedly recognised by the perusal of his very important work.

The Pertinacity and Predominance of Weeds.—Considering weeds to be plants of the nature of herbs which tend to take prevalent possession of soil used for man's purposes, irrespective of his will, Professor Asa Gray inquires, in a recent paper in *Silliman's Journal*, whether weeds have any common characteristic which may give them advantage, and why most of the weeds of the United States, and probably of similar temperate countries, should be foreigners. This latter is strikingly the case on the Atlantic side of temperate North America, where the weeds have mainly come from Europe, and the common answer to the question must be largely true—viz., that as the region was not really forest clad, there were few of its native herbs which, if they could bear the exposure at all, could compete on cleared land with immigrants

from the Old World. A certain number of the weeds in that region have come from the west and south, some with rather rapid strides in recent years owing to increased means of communication; and there are also native American weeds, indigenous to the region, which have become strongly aggressive through changed conditions. Professor Claypole, of Ohio, has tried to account for the predominance of Old World weeds in the Atlantic United States by supposing a greater "plasticity" in European than in American flora (the plant more easily adapting itself, if the change be not too great or sudden, to its new situation, and taking out a new lease of life as a weed). But Professor Gray regards this view as purely hypothetical. Again, Mr. Henslow thinks that weeds or intrusive dominant plants generally have a common characteristic to which this dominance may be attributed —viz., that they are in general self-fertilized plants. The question whether the weeds which Europe has given to North America are more self-fertilizing or less subject to cross-fertilization than others is examined by Professor Gray, and he is led to answer that self-fertilization is neither the cause nor a perceptible cause of the prepotency referred to. A similar conclusion is justified by a cursory examination of the indigenous weeds of the Atlantic States, and of the prevalent species in California, which (as might be expected) are mostly indigenous species or immigrants from South America, though the common weeds of the Old World, especially of

Southern Europe, are coming in.
—*Times*.

Animal Rubber.—An insect, which produces a species of india-rubber, has been recently discovered in the district of Yucatan, Central America, by an American explorer. It is called *neen*, and belongs to the Coccus family; feeds on the mango tree, and swarms in these regions. It is of considerable size, yellowish brown in colour, and emits a peculiar oily odour. The body of the insect contains a large proportion of grease, which is highly prized by the natives for applying to the skin on account of its medicinal properties. When exposed to great heat the lighter oils of the grease volatilise, leaving a tough wax, which resembles shellac, and may be used for making varnish or lacquer. When burnt, this wax, it is said, produces a thick semi-fluid mass, like a solution of india-rubber.—*Scientific American*.

Electricity for Bees.—An ingenious Dutchman has hit upon a novel method of rendering the busy bee insensible at the time when it is requisite to gather the honey. He simply passes a strong electric current through the hive, and paralyses the inmates. It is rather difficult to see by what means he is able to do this without killing the bees outright, but according to report the little workers soon recover themselves, and commence once more to improve the shining hour.

Gigantic Cuttle-Fish.—Many interesting facts relating to the North American giant cuttle-fish have been recently laid by Professor Verrill before the Connecticut Academy. The banks of

the Newfoundland coast would seem to be the headquarters for these cephalopods. One was seen on the beach at Lance Cove, Trinity Bay, still alive, and struggling desperately to escape. It was being borne in by a "spring tide" and high inshore wind. In its struggles to get off it ploughed up a trench or furrow about 30 ft. long, and of considerable depth, by the stream of water which it ejected with great force from its siphon. When the tide receded it died. On careful measurement, its body was nearly 11 ft. long, its short arms were 13 ft. in length and much thicker than a man's thigh, and its tentacular arms were each 33 ft. long.

But this was scarcely more than half the size of a specimen taken at a place called Thimble Tickle. Stephen Sherring, a fisherman, was out in a boat with two other men. Not far from the shore they observed some bulky object, and supposing it might be part of a wreck they rowed towards it, and to their horror found themselves close to a huge fish, having large glassy eyes, which was making desperate efforts to escape, and churning the water into foam by the motion of its immense arms and tail. It was aground, and the tide was ebbing. From the funnel at the back of its head it was ejecting large volumes of water. At times the water thrown out was as black as ink. Finding the monster partly disabled, the fishermen plucked up courage and ventured near enough to throw the grapnel of their boat, the sharp flukes of which having barbed points sank into the soft

body. To the grapnel they had attached a stout rope, which they carried ashore and tied to a tree. As the cuttle-fish felt itself moored, its struggles were terrific, and in a dying agony it flung its ten arms wildly about, and as the tide receded it became exhausted and died. It was a splendid specimen, the largest yet actually measured, being 20 ft. in length from its beak to its tail, and with arms upwards of 35 ft. long. Such a cuttle-fish as this met with on the surface of deep water might well give rise to exaggerated accounts.

Spread of Disease by the Agency of Earthworms.—Recent researches by M. Pasteur appear to throw considerable light on the origin of anthrax, or splenic fever, and allied diseases, which attack cattle, sheep, &c. When an animal dies of anthrax it is not uncommonly buried on the spot. The conditions of putrefaction prove fatal to the small parasitic organism, or *bacteridium*, which is abundant in the blood at death. The gas given off causes it to break up into dead and harmless granulations. But before this can occur not a little of the blood and humours of the body has escaped into the ground about the carcase, and here the parasite is in an aerated medium favourable to the formation of germs. These corpuscular germs M. Pasteur has found in the soil, in a state of latent life months and years after the carcase was buried; and by inoculation of guinea pigs with them, has produced anthrax and death. Now, it is specially notable that such germs have been met with in the

earth at the surface above the place of burial, as well as near the body. The question arises, How came they there? And it would appear that earthworms are the agents of conveyance. In the small earth-cylinders of fine particles which these creatures bring to the surface and deposit after the dews of morning or after rain, one finds, besides a host of other germs, the germs of anthrax. (The same process was proved also by direct experiment; worms kept in ground with which *bacteridium* spores had been mixed, were killed after a few days, and many of the spores were found in the earth-cylinders in their intestines.) The dust of this earth, after the cylinders had been disaggregated by rain, gets blown about on the neighbouring plants, and the animals eating them thus receive the germs into their system. It is suggested that possibly other diseased germs, not less harmless to worms, but ready to cause disease in the proper animals, may be in like manner conveyed to the surface in cemeteries. This would furnish a fresh argument for cremation. The practical inference as to anthrax is, that animals which have died of this should not be buried in fields devoted to crops or pasturage, but (wherever possible) in sandy, calcareous ground, poor and dry—unsuitable, in a word, for worms.

Notes on Amber.—The complete history of amber is yet to be written, but when written it will form a most interesting and instructive volume. Known and valued from the very earliest times, it has a name in most

languages, and its Greek name, *electron*, has left its impress upon our own and most other tongues. Nearly 2,000 years ago Pliny, the naturalist, wrote that amber was the fossil resin of an extinct cone-bearing tree, and modern science can say of it but little more.

In a short paper on this subject laid before a meeting of the American Association for the Advancement of Science, Erminnie A. Smith gives an epitome of what is known on the subject. The original amber-producing forest probably reached from Holland over the German coast, through Siberia and Kamschatka, even to North America. One of the most celebrated deposits is on the peninsula of Samland, a portion of Prussia, nearly surrounded by the Baltic Sea. The northern part of this region, constituting the promontory of Brusterort, is hilly, and the coast banks are often from 150 ft. to 300 ft. high. At one time all the amber found here, even by the peasants in ploughing, belonged to the German Government; the finder, however, receiving one-tenth of its value. For a piece in the Berlin Museum weighing 18lb. the finder is said to have received a thousand dollars. During stormy weather, when the wind and waves beat violently against this coast, a great quantity of amber is washed up. The total yearly product is, however, apparently on the decrease, and so the price of amber is on the increase.

Professor Zaddach, of Königsberg, concludes that the trees yielding the amber resin must have grown upon the green sand-

beds of the cretaceous formation, which at the time formed the shores of estuaries where the lower division of the tertiary accumulated. Immediately over the amber-producing strata rest the brown coal-beds, the fossil plants found in which differ entirely from the amber-bed flora. Many insects and plants are found embalmed in the amber. Over 800 species of the former have been named, and over 160 of the latter. When collected it is, for the purposes of trade, divided into classes, the best pieces being generally sent in the rough to Constantinople, where they are in great demand for the mouthpieces of pipes. The smaller-sized pieces are used for beads, &c., and the impure morsels for the manufacture of succinic acid, or in the preparation of amber varnish. From other resins amber is distinguished by its hardness, its lesser brittleness, the much higher temperature required to reduce it, and its greater electric action. At certain temperatures it is also extremely flexible. The imitations of amber are numerous, but all are detected by the use of the electrometer. While the colour of true amber is generally yellow, it occurs in all shades, from pure white to black.

Amber was intermingled with the myths and religion of the Greeks, their legends ascribing its origin to—

"the sweet tears shed
By fair Heliades, Apollo's daughters,
When their rash brother down the
welkin sped,
Lashing his father's sun-team, and
fell dead
In Euxine waters."

Amber literature, indeed, has an interest of its own. Books in all languages refer to its many supposed qualities, and the insects contained in it have given rise to many a quaint metaphor.

Fish with Brains.—Mr. Seth Green, superintendent of the New York State Fish Hatchery, says that in the first pond at the hatchery there are 5,000 large brook trout that were all captured with the fly in unfrequented streams and lakes of the Adirondack region. These trout, he says, have convinced him that fish have reasoning powers and memory. When they were hooked and reeled slowly to the boats, they had time and opportunity to note the form and character of the tackle that made them prisoners. They have never forgotten that. They will follow Mr. Green as he walks about the pond. Let him have a walking-stick and a fishing-rod hidden behind his back. If he reveals the former to the fish, by holding it out over the water, they pay no attention to it; but the moment he produces the rod with its tackle, away they all scamper to the distant parts of the pond. Mr. Green says he will permit anyone to cast a fly in that pond to his heart's content, as he is satisfied that not one of the trout will come near it, so vividly do they remember their enemy of five years ago. At a recent meeting at New York, Mr. Green stated that he is trying to see if brook trout can be improved by mixing different kinds, since it is known that constant interbreeding of animals deteriorates them in size and intellect. Mr. Green rather amused the meeting

by maintaining that fish had reasoning powers, and that he did not see why they could not be improved in point of intellect. "If," said he, "we can breed a trout that has sense enough to avoid the nets of the poachers on Long Island, I am under the impression that some clubs that I know of would be willing to give somebody a chromo."

The Influence of the Electric Light upon Vegetation.—At a meeting of the Royal Society on the 4th of March, 1880, Dr. C. W. Siemens, F.R.S., gave a detailed description of some of the experiments upon the above subject. The method pursued was to plant quick-growing seeds and plants, such as mustard, carrots, swedes, beans, cucumbers, and melons, in pots, and these pots were divided into four groups, one of which was kept entirely in the dark; one was exposed to the influence of the electric light only; one to the influence of daylight only; and one to daylight and electric light in succession. The electric light was applied for six hours each evening—from 5 to 11—and the plants were then left in darkness during the remainder of the night. The general result was that the plants kept entirely in the dark soon died; those exposed to the electric light only, or to daylight only, thrived about equally; and those exposed to both day and electric light thrived far better than either, the specimens of mustard and of carrots exhibited to the Society showing this difference in a very remarkable way.

Dr. Siemens only considers himself as yet on the threshold of the investigation, but thinks the ex-

periments already made are sufficient to justify the following conclusions :—1. That electric light is efficacious in producing chlorophyll in the leaves of plants, and in promoting growth. 2. That an electric centre light equal to 1,400 candles placed at a distance of two mètres from growing plants appeared to be equal in effect to average daylight at this season of the year; but that more economical effects can be obtained by more powerful light centres. 3. That the carbonic acid and nitrogenous compounds generated in diminutive quantities in the electric arc produce no sensible deleterious effects upon plants enclosed in the same space. 4. That plants do not appear to require a period of rest during the 24 hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight, and during the night to electric light. 5. That the radiation of heat from powerful electric arcs can be made available to counteract the effect of night frost, and is likely to promote the setting and ripening of fruit in the open air. 6. That while under the influence of electric light plants can sustain increased stove heat without collapsing—a circumstance favourable to forcing by electric light. 7. That the expense of electro-horticulture depends mainly upon the cost of mechanical energy, and is very moderate where natural sources of such energy, such as waterfalls, can be made available.

The paper gave rise to a highly-interesting discussion, in which it was pointed out that the evidence afforded of the practical identity, as regards vegetation, of solar and

electric light, besides the probability that it would be turned to immediate account by horticulturists, would afford great facilities for the scientific investigation of the influence exerted by light, as compared with other agencies, in promoting the formation of the active principles or most valuable constituents of plants, such as the quinine of the cinchona bark, the gluten of wheat and so forth. Before concluding his observations, Dr. Siemens placed a pot of budding tulips in the full brightness of an electric lamp in the meeting-room, and in about 40 minutes the buds had expanded into full bloom

Lichens of the Polar Regions.—Professor Fries, of Upsala, has at the suggestion of Sir Joseph Hooker, investigated the lichens collected during the English Polar Expedition of 1875-76. Up to 1876 but three species of lichens are mentioned in published works as certainly found to the north of 81 deg. north lat., and these were found by Julius Payer at Cape Fligely (82 deg. 5 min.). The lichens brought back by the expedition under Capt. Sir G. S. Nares, therefore, possess a good deal of interest. Such plants cannot, of course, prove by the luxuriance of their forms or by the brilliancy of their colouring at all attractive to the general public, but they are of great interest to the botanist; and the importance that attaches to them as belonging to the flora that approaches nearest to the North Pole, is not their smallest claim to notice. The collections of Mr. Hart were made between 75° 56' N. lat. and 81° 42' N. lat.; those of Captain Fielding between 78° 40' N. lat. and 82° 41' N. lat.;

while Lieutenant Aldrich collected one species on the very shore of "the palaeocrystic sea," the northernmost spot trodden by man ($83^{\circ}6'30''$ N. lat.). The fruticolous and foliaceous lichens were represented by a very few of these undeveloped specimens; and it seemed strange that while the musk-ox was found, yet there was no appearance of its food, the reindeer moss. However, Captain Fielding says that the *ovibos moschatus* in Grinnell Land does not feed on lichens, but on grasses, willows, and other flowering plants, and he further points out that "the lichen growth increased in size of species with increase in altitude; on the shore line only the smaller red, yellow, and black and gray lichens which covered small stones and pebbles were met with. At an elevation of 1,200 ft. the larger lichens were very abundant. The top of the 'Dean' was conspicuously clad with the broad flat thallus of *gyrophora discolor* and by the delicate network of fine dark hairs of *permelia lanata*. The growth of these two species increased at an altitude of 1,400 ft., which was the highest elevation reached that was free from snow."

It is well known that, having regard to their different habits of living, lichens are distinguished as growing on stone, wood, moss, and earth. To speak of wood lichens in arctic regions is impossible, as no trees are to be found there. Only a few fragments of the wood of a sallow were in the collection. The largest of these fragments was a piece of a dead stem of *salix arctica*, without bark. This, the finest piece of indigenous timber met with in Grinnell

Land, was a little over 2 in. in length and about half-an-inch in diameter. On cross section it showed 40 annual circles of very different size. But most of the lichen species growing on the Saltow tings were muscicolous, and some even sacicolous, indicating the capacity of wood in these regions to resist decay or any sort of destruction. It is, as it were, "aere perennius," surpassing most sorts of stones, which get split and destroyed by the joint action of frost and water. Professor Fries enumerates 102 species of arctic lichen in his memoir, which may be seen by the reader in the *Journal of the Linnaean Society*.

A New Vine.—A French explorer, M. Lecart, who is at present on the banks of the Niger, writes home from "Koundian (Gangaran), July 25, 1880," that he has discovered a new vine, which promises to be of great economical value. He says the fruit of the vine is excellent and abundant, its cultivation very easy, its roots tuberose and perennial, while its branches are annual. It can be cultivated as easily as the dahlia. He himself had been eating the large grapes of the vine for eight days, and found them excellent, and he suggests that its culture ought to be attempted in all vine-growing countries, as a possible remedy against phylloxera. He is sending home seeds for experiment, both in France and Algeria, and will bring home specimens of the plant at all stages.

All About Snakes.—A lecture was delivered by Professor Huxley on the subject of snakes, at the

London Institution, in the winter of 1879. Than snakes, he said, there were, in the popular apprehension, few animals more symbolical of degradation and horror. Quoting the primeval curse in Genesis, he remarked that no creatures seemed more easily destroyed by man, and few less able to defend themselves. Few wounds would be less harmful than a snake's bite were it nothing more than the sudden closing of the teeth. Yet there are not many animals gifted with so many faculties. It can stand up erect, climb as well as any ape, swim like a fish, dart forward, and do all but fly in seizing its prey. The destructiveness of snakes to man was illustrated by the fact that 20,000 human lives are yearly lost in India by their poison, and it might safely be said they are a more deadly enemy to our race than any other beasts of the field.

Professor Huxley spoke first of the three classes indigenous to our climate—the ringed snake, the coronella, and the viper. Of these, the viper alone was venomous, which the differences between its structure and that of the harmless British snakes helped to explain. It might be that the reason there were no snakes in Ireland was the multiplicity of its other plagues. Everybody must be struck with the beauty of the harmless snakes, which formed the overwhelming majority—especially the grace with which they wreathed their bodies into circles, and their fine eyes. The venomous snakes were not so beautiful. None admired our viper, with its yellowish scales. To adults its bite was far seldomer serious than to the young.

Passing to snakes in general, of which there are many hundreds of distinct species, the lecturer illustrated in great detail the adaptation of their organisation to its manifold work. Very graphic was his description of the manner in which some of the more destructive snakes dart suddenly on their prey, twisting themselves round its body, crushing it into a shapeless and writhing mass, and at last swallowing it whole.

He pointed out some very curious arrangements in the anatomical mechanism and jaw-bones illustrative of the statement that the snake cannot properly be said to swallow its prey; he holds on to it rather, gradually working it down his throat in a most leisurely manner, but never letting it go. He would take a sleep for six weeks before giving up his task, and if the morsel were really too big, would sometimes die in the effort to get it down. Of course, the snake required a very fully-developed and effective apparatus of salivary glands for this purpose. The poison-bag of the venomous snakes was nothing but a modification of the salivary glands of the harmless species, the structure of both kinds being in almost all respects not only parallel throughout, but almost identical. As another instance of the close relationship, it was shown that the sharp channel-needle which conveys the poison of the cobra and its congeners, is nothing but the development of the tooth which these murderous reptiles possess in common with innocuous snakes. The fact that the salivary gland was the poison laboratory of the deadly snakes, as well as the

known properties of the saliva of dogs or other living creatures affected with rabies, appeared to Professor Huxley to point out the direction in which lay the solution of the difficult problem of the cause of snake-poisoning, and of a possible antidote against it. At present, there was no man living who could heal the bite of the cobra, except by cauterisation in very fresh cases.

A Caution to Snakes.—A lecture under this title was delivered by Mr. Ruskin, at the London Institution, on the 17th of March, 1880. Alluding to the fact that Professor Huxley had opened the lectures for the season in that theatre with one on "Snakes," Mr. Ruskin said he trusted the seeming antagonism between himself and that distinguished man, to whose genius as well as to that of Mr. Darwin he paid a high tribute of respect, would not be misunderstood. The subject was appropriate to St. Patrick's Day.

Pointing to his diagrams, he singled out one representing the constellation Draco as enlarged from a common celestial globe, to show the smallness of the assistance hitherto accepted by modern astronomy from modern zoology. Mr. A. Severn had drawn the head of the same, giving a general type of modern dragon idealism, with which was contrasted a Greek ideal, being the Lernæan Hydra, drawn by Mr. Ruskin himself from a coin of Phæstus. The lecturer observed that the Greek who struck that coin had seen in mental vision the seven-headed serpent slain by Herakles.

The names of the snake tribe in the great languages were then

vividly explained and illustrated. In Greek, *ophis* meant the "seeing" creature, especially one that sees all around it; and *drakon*, one that looks well into a thing or person. In Latin, *anguis* was the strangler; *serpens*, the winding creature; *cobuber*, the coiling animal. In our own Saxon, the "snake" meant the crawling creature; "adder" denoted the groveller. In illustration of the Greek terms Mr. Ruskin remarked that, when he sketched from life the head of the rattlesnake threatening, the creature seemed to be looking at him out of the back of its head.

The lecturer then proceeded to speak of the nature of snakes. It was important to know what genus, or, as he would say, gens, and species meant. The former was accordingly defined as meaning race, and the latter as equivalent to family. Between such races and families there were always connecting links, for between even the eagle and the trout the penguin looked like a link, just as the bat was between the swallow and the field-mouse. The general or races of snakes seemed to be four. There was the lizard which had dropped its legs; the duck which had dropped its wings; the fish which had dropped its fins; lastly, some sort of honeysuckle with a head stuck on. These classes were spoken of in detail.

Under the last head Mr. Ruskin referred to snapdragon and other flowers, the analogy between which and snakes had been observed for ages; also to carnivorous plants, to climbers, and to creepers, such as honeysuckle;

woodbine, and ivy. The principal diagram was a drawing by Mr. A. Severn of part of Giotto's sculpture of the Creation of Eve, whose danger is foretold by the twining ivy above. Another diagram was a sketch of the cranberry blossom by the lecturer. In concluding, Mr. Ruskin, politely crediting his audience with all such wisdom of the serpent as was desirable, advised them not to eat their meat before tasting it, like the boa which swallowed its blankets. On the other hand, they might do worse than stick to wholesome intellectual food with the tenacity of the ~~same~~ animal, which never lets go its prey until it has enveloped it as in a sack.

The Instincts and Emotions of Fish.—At the opening meeting of the session of the Linnean Society, in the winter of 1879, Dr. Francis Day read a paper on the instincts and emotions of fish. The study of the subject had, he said, received but very little attention in late years, most naturalists apparently accepting Cuvier's view that the existence of fish is a silent, monotonous, and joyless one. This is, however, by no means the case, though we cannot, of course, expect to find special expressions so well marked as in higher animals, because fish have immovable eyelids, have their cheeks covered by scales, and have no external ears, whose motions in some animals are so expressive. The most numerous recorded observations are those which refer to the regard for the young. Some fish are polygamous, but among the monogamous there is seen a watchfulness over the young, in which

the male often plays as important a part as the female. With several species of the ophiocephalus it is the duty of the male to prepare the nest as well as to take care of the young. In some classes, who are not nest-builders, the eggs are carried about in the cheek-hollows of the male. In the case of the gasterosteus the nest, besides being guarded by the male, is gradually opened more and more to the action of the water, and a current is directed over it by a motion of the body.

That fish may be trained to come when called is well known in all parts of the world, though as this is generally associated with feeding, it may not be taken to mean much. Cases have been noticed of male fish remaining at the same spot in a river from which the female has been removed, and in one case, where a pair were separated for three weeks, they became miserable and seemed near death; while, on being re-united, they again became happy. In aquaria, fish have been known to attach themselves to particular spots, and battles ensue with intruders. Such fights have been watched, and it has been noticed that while the conqueror assumes more brilliant hues, the conquered sneaks off with his gay colours faded. In their artfulness in obtaining food fish show much intelligence, which is more especially marked with those that eat smaller fish, which they entice within their reach. That some classes are capable of an organization for acting together for common good is shown by the way they unite to attack a common enemy. The subject is one

that deserves much more attention than it has hitherto received.

The Orang-outang.—Mr. W. T. Hornaday, in the last volume of the "Proceedings of the American Association," gives some new and interesting information on the orangs of Borneo, the results of his own observation during a lengthened stay in that island. Leaving the *genus homo* out of the question, the orang-outang occupies the third place from the highest in the animal kingdom; the gorilla being first, and the chimpanzee second. The most striking feature of the orang is its great size and general resemblance to man. The chest, arms, and hands are especially human-like in their size and general outline. So far as Bornean species are concerned, Mr. Hornaday is certain that each individual differs as widely from his fellows and has as many facial peculiarities belonging to himself as can be found in the individuals of any unmixed race of human beings. The faces of the more intelligent orangs are capable of a great variety of expressions, and in some the exhibition of the various passions which are popularly supposed to belong to human beings alone is truly remarkable.

Mr. Hornaday had in his possession in Borneo four young living orangs. Three were dull and intractable, but the fourth was a perpetual wonder to both Europeans and the natives themselves. Mr. Hornaday had that little animal in his possession for four months, and for a number of weeks it lived in the room with him, so that he watched it almost

constantly. The expression of the face was highly intelligent, while the intellectual development of its forehead and entire cranium would have been quite alarming to any enemy of the theory of evolution. This specimen was a fine healthy male infant, from seven to eight months old, height 22½ inches, extent of arms 37 inches, weight 15½ lbs. He exhibited fully as much intelligence as any child under two years of age, with all the emotions of affection, dislike, anger, fear, cunning, playfulness, and even *ennui*. When teased beyond endurance he would first whine piteously; but if continued he would throw himself upon the floor, kicking and screaming, and catching his breath as loudly and naturally as any spoiled child. He was afraid of strangers as a rule, but decidedly attached to Mr. Hornaday and his Chinese servant. When alarmed at the presence of a large dog or other animal, he would shuffle up to Mr. Hornaday as fast as possible and climb with all haste into his arms. Whenever a cat happened to come near him, he would immediately grab it by the tail with the very same action and bright mischievous expression of countenance as we have all seen in human children. Male orangs are much given to fighting, and like many roughs of the human species, they seem given to attacking each other's fingers with their teeth. Whenever Mr. Hornaday's baby orang became angry with him, it would, if possible, seize him by the wrist and draw his hand to its mouth until it could seize one of his fingers with its teeth; but while it would make a

great feint of giving him a terrible bite, it knew enough not to bite harder than he could comfortably endure.

The nest of the orang-outang consists of a quantity of leafy branches broken off and piled loosely into the fork of a tree. He usually selects a small tree, and builds his nest in the top; he always builds his nest low down, often within 25 ft. of the ground, and seldom higher than 40 ft. It is usually 2 ft. in diameter and quite flat on the top. The branches are merely piled crosswise; in fact, the orang builds a nest precisely as a man would build one for himself were he obliged to pass a night in a tree-top and had neither axe nor knife to cut branches. Mr. Hornaday has seen one or two such nests of men in the forest, where the builder had only his bare hands with which to work, and they were just as rudely constructed, of just such materials, and about the same general position as the average orang nest. Upon this leafy platform the orang lies prone upon his back with his long arms and short thick legs thrust outward and upward, firmly grasping while he sleeps the nearest large branches within his reach. An orang probably uses his nest several nights in succession, but never after the leaves become withered and dry, no doubt for the reason that the bare branches afford an uncomfortable resting-place. Mr. Hornaday never saw nor heard of any house-building

would invariably cover his head and body with straw or loose clothing the moment it began to

rain, even though he was under a roof all the time.

"Let any naturalist," Mr. Hornaday concludes, "who is prejudiced against the Darwinian views go to the forests of Borneo. Let him there watch from day to day this strangely human form in all its various phases of existence. Let him see it climb, walk, build its nest, eat and drink, and fight like human roughs. Let him see the female suckle her young and carry it astride her hip precisely as do the coolie women of Hindostan. Let him witness the human-like emotions of affection, satisfaction, pain, and childish rage; let him see all this, and then he may feel how much more potent has been this lesson than all he has read in pages of abstract ratiocination."

Injurious Insects and Small Birds.—Four years ago, Miss E. A. Ormerod organised a series of observations to be made in various parts of Great Britain with regard to the injuries done to crops, both garden and field, by insect pests. Every year since these observations have been continued, and each annual report shows that the number of persons giving information is steadily increasing. The "Notes of Observations of Injurious Insects" during the year 1879 has lately been issued, and contains observations on nearly 60 insects by over 200 persons.

An idea being prevalent that "cold kills the grubs," the opportunity was taken during the great

1879-80 of examining the state of all larvæ and pupæ that could be found fully exposed to its influence,

whether unsheltered, under bark, or in frozen ground, and it was found that in all cases, even when the earth was frozen so hard that the mass had to be broken up with a hammer, and the larvæ or pupæ were perfectly rigid, that on thawing they did not appear to be in any way injured ; and in the cases of the larvæ of the cabbage weevil (which was the only case in which any immediate action was to be expected) they continued the operation of making their earth cases for pupation as if nothing had happened. In other respects the extreme severity of the two winters was favourable to insect preservation, as large numbers were secured from bird attack under the snow or frost-bitten ground ; the excessive cold also caused an almost unprecedented mortality among the birds, especially among the turdidae and starlings. The general returns do not show that any kind of injurious insect has been lessened in amount during the past year, if we except the turnip fly. This was but little prevalent, but as many of the returns state "no turnips, therefore no fly," it may be conjectured that its absence was owing chiefly to the general failure of that crop.

The various reports, which occupy 44 quarto pages, show that among the lepidoptera some of the injurious kinds have been excessively plentiful in various localities, as have also been the surface caterpillars. Among coleoptera, the weevils of various species have not failed us, neither have the injurious diptera. The crane-fly larvæ have fairly ravaged whole districts, and the carrot fly

and the celery fly have been unusually plentiful. In many districts the onion crops have been much damaged by the onion fly, but it has been particularly hurtful in the Isle of Mull. Great injury has been done in many places by gooseberry sawfly, and locally by other species. *Cynips Kollari* appeared "like a scourge" in Tipperary. On the whole, although the previous winter was very severe, there was a great increase in the amount of destruction done to crops by injurious insects. That this is chiefly due to the excessive mortality among small birds is also shown.

The report for 1879-80 contains some notes of observations with regard to small birds as insect destroyers. Among the various species serviceable generally on forest trees, apple trees, and fruit bushes, the report mentions the titmice, including the blue, cole, marsh, longtailed, and great tit (and of these the blue tit may be specially observed at work among the aphides on gooseberry bushes); also the warblers, woodpeckers, nuthatch, and tree-creepers. The lesser spotted woodpecker is noted as specially frequenting the apple; the golden-crested regulus frequents the Scotch pines, spruce and other conifers; the bearded tit, yellow wagtail, titlark, wren, cuckoo, and water rail are mentioned as serviceable in osier beds and reeds, and in marsh hay. Among the gooseberry, currant, and raspberry bushes, the titmice and warblers, the wren, and the cuckoo are noticed as of special use. Among cabbage and turnip crops the partridge, spotted flycatcher, swifts, swallows, and

martins are serviceable, and also shrew-mice, moles (if not too injurious to agricultural work), and bats. On grass, besides the warblers, swallows, swifts, martins, and partridges before mentioned, the wagtails, pipits, and starlings, were all of service ; and the shrews and bats, the slowworm, and the toad help at the work. The cuckoo is of special service from not refusing hairy larva, and the fly-catcher as destroying the white butterflies ; while bats eat the moths of the surface caterpillars (*Noctuæ* of various species), and shrews prey on beetles. It is also shown that some degree of discrimination is desirable in the encouragement of birds ; but, generally speaking, the encouragement of the insectivora, whether bird, beast, or reptile, would make a very important difference in the amount of insect presence.

Sir John Lubbock on Ants.—In a further instalment of his observations upon the economy and habits of these insects, laid before a meeting of the Linnean Society in June, 1880, Sir John commences by relating his fresh experiments on their powers of communication. A dead blue-bottle fly was pinned down, and after vain efforts at removal, the selected ant hied home and emerged with friends, who slowly, and evidently incredulously, followed their guide. The latter, starting off at a great pace, distanced them, and they returned, only, however, to be again informed, come out, and at length be coaxed to the prey. Several experiments, made with different species of ants and under varied circumstances, seem to indicate the possession of some-

thing approaching language. It is impossible to doubt that the friends were brought out by the first ant, and, as she returned empty-handed to the nest, the others cannot have been induced to follow merely by observing her proceedings. Hence the conclusion that they possess the power of requesting their friends to come and help them. In other experiments, testing the recognition of relations, although the old ants had absolutely never seen the young ones until the moment (some days after arriving at maturity) they were introduced into the nest, yet in all cases they were undoubtedly recognised as belonging to the community.

It would seem, therefore, to be established that the recognition of ants is not personal and individual, and that their harmony is not due to the fact that each ant is acquainted with every other member of the community. It would further appear from the facts that they recognise their friends even when intoxicated, that they know the young born in their own nest, even when they have been brought out of the chrysalis by strangers ; and that the recognition is not effected by means of any sign or password.

With regard to workers breeding, the additional evidence tends to confirm views previously advanced, that when workers lay eggs, males are always the issue of these. Without entering into details of instances, it may broadly be affirmed that in the queenless nests males have been produced, and in not a single case has a worker laid eggs which have produced a female, either a queen or

a worker. On the contrary, in nests possessing a queen, workers have been abundantly produced. These curious physiological facts lead to the presumption that, as in the case of bees so also in ants, some special food is required to develop the female embryo into a queen. In Sir John's nests, while from accidents and other causes many ants are lost during the summer months, in winter, nevertheless, there are few deaths. Specimens of *Formica fusca* and *F. sanguinea*, still lively, are now four, and others five, years old at least. The behaviour to a strange queen often results in her being ruthlessly killed ; yet as communities are known to have existed for years, queens must occasionally be adopted. With the view of trying how far dislike and passion might be assuaged by a formal temporary acquaintance, a queen of *F. fusca* was introduced into a queenless nest, but protected by a wire cage, and after some days the latter was removed, but the queen was at once attacked. Mr. M'Cook nevertheless relates an instance of a fertile queen of *Cremastogaster lincolata* having been adopted by a colony of the same species. Such difference in conduct, Sir John suggests, may be due to his own ants having been living in a republic, for it is affirmed that bees long without a queen are strongly averse to adopting or accepting another. Furthermore, if a few ants from a strange nest are put along with a queen they do not attack her, and if other ants are by degrees added, the throne is ultimately secured. In pursuance of experiments to test the sense of direction, some ants were trained to go for their food over a wooden bridge made up of segments. Afterwards, when they had become accustomed to the way, and an ant was in the act of crossing, a segment was suddenly reversed in direction, evidently to the ant's discomfiture ; she then either turned round, or, occasionally, after traversing the bridge, would return. When, however, similar pieces of wood were placed between nest and food, and the ant at the middle piece, those at the ends being transposed, the ant was not disconcerted. In other instances a circular paper disc was placed on a paper bridge, and when the ant was on the disc this was revolved, but the ant turned round with the paper. A hat-box, with holes of entrance and exit pierced at opposite sides, was planted across the line to the food ; when the ant had entered and the hat-box was reversed, therefore with holes in opposite directions, the ant likewise wheeled about, evidently retaining her sense of direction. Again, with the insect *en route*, when the disc or box with the ant within was merely shifted to the opposite side of the food, without being turned round, the ant did not turn round, but continued in what ought to have been the direction of the food, and evidently was surprised at the result on arriving at the spot where the food had previously been. In opposition to the opinion expressed by M. Dewitz, Sir J. Lubbock regards the ancestral ant as having been aculeate, and that the rudimentary condition of the sting in *Formica* is due to atrophy, perhaps attributable to

disuse. A ground plan of the nest of *Lasius niger* is given by Sir John, which exhibits an intricate, narrow, and winding entrance passage ; the main nest-cavity is further supported by pillars, and here and there protected recesses are formed, evidently strategetical retreats in times of danger.

Studying the relations and treatment of the Aphides, or plant-lice, by the ants, Sir John clearly demonstrates that not only are the Aphides kept and protected in the ants' nests, but the eggs of *Aphis*, laid outside on the leaf-stalks of its food-plant in October, and exposed to risks of weather, are carefully brought by the ants into their nests, and afterwards tended by them during the long winter months until March, when the young are again brought out and placed on the young vegetable shoots. This proves prudential motives, for though our native ants may not lay up such great supplies of winter stores of food as do some of those found abroad, they thus nevertheless take the means to enable them to procure food during the following summer. The fact of European ants not generally laying up abundant stores may be due to the nature of their food. Insects and small animals form portion of their food, and these cannot always be kept fresh. They may also not have learned the art of building vessels for their honey, probably because their young are not kept in cells, like those of the honey-bee ; and their pupæ do not construct cocoons, like those of the humble-bee. Our English ants, nevertheless, store proportionately to their

size ; for if the little brown garden ants be watched milking their Aphides, a marked abdominal distension is observable. The paper concludes by a history and technical description of a new species of Australian honey ant. This corroborates Wesmael's strange account of the Mexican species. Certain individual ants are told off as receptacles for food ; in short, they become literally animated honey-pots.—*Athenaeum*.

The Indian Elephant.—A lecture on the history of the Elephant was delivered at Simla, before the Viceroy, by Mr. Sanderson, in July, 1880. The usually received notions of the elephant's height are much exaggerated. Out of many hundreds which Mr. Sanderson measured in the south of India and Bengal he only found one male of 9ft.10in. vertical height at the shoulder ; though the Rajah of Nahun has at present a tusker which measures 10ft. 5 $\frac{1}{2}$ in. Few female elephants attain 8ft. at the shoulder, though Mr. Sanderson has seen one of 8ft. 5in. Twice round an elephant's forefoot gives his height to within an inch or two.

As regards age, looking to their peculiar dentition and other circumstances, Mr. Sanderson thinks it by no means improbable that elephants live to 150 or 200 years. There seems to be somewhat the same mystery about dead elephants as about dead donkeys. No one has ever, apparently, seen the remains of a dead elephant, and this circumstance is so remarked as to have given rise to the belief among some wild tribes that wild elephants never die ;

whilst others believe that there is a place unseen by human eye to which they retire to end their days. In Mr. Sanderson's wanderings for years through elephant jungles, he has not only never seen the remains of an elephant that had died a natural death, but he has never met anyone among the jungle tribes or professional hunters who had. The Cingalese have a superstition that on feeling the approach of dissolution the elephant retires to a solitary valley and there resigns himself to death. There is a similar belief in India, but Mr. Sanderson shows that it is untenable.

One would not expect to hear that elephants were expert swimmers, though they can no more jump a trench eight feet wide than they can dance a hornpipe. Such, however, seems to be the case, from the fact that large numbers of them are annually sent across the tideway of the Ganges between Dacca and Barrackpore, and are sometimes six consecutive hours without touching the bottom. Mr. Sanderson has seen an elephant swim a river 300 yards wide with his hind legs tied together. They are sometimes drowned, apparently by being attacked with cramps or a fit.

The belief that wild elephants have decreased in India is shown by Mr. Sanderson to be incorrect. The records for the past fifty years attest that there is no diminution in the number now obtainable in Bengal, whilst in Southern India elephants have become so numerous of late years that they are annually appearing in places where they have never been heard

of before. In fact, Mr. Sanderson thinks that unless something be done, the rifle will have to be used to protect the ryots of tracts bordering upon elephant jungles. To give an idea of the number of wild elephants in some parts of India, the lecturer stated that during the past three years 503 elephants have been captured by the Dacca Kheddah establishment in a tract of country forty miles long by twenty broad in the Gavo Hills, whilst not less than 1,000 were met with during the hunting operations. Mr. Sanderson does not think there is any danger of the elephant becoming extinct in India. He also considers that by proper restrictions in the method of, and greater facilities for, hunting, the cost of elephants to Government might be considerably reduced.

The lecturer gave a graphic description of the different modes of capturing and training the elephant. Here is an extract:—“When an elephant chases the men they betake themselves to shelter of tree trunks, bamboo clumps, or long grass, and it is astonishing to see how frequently they escape uninjured. I have known many cases of men standing against a tree, or hiding in tufts of long grass within a couple of yards of elephants that were pausing in indecision, without being discovered, though the elephants were evidently aware of their close proximity, as they kicked up the ground in anger and then made off. In such cases the slightest movement would have led to the hunters being instantly trampled to death. Men are frequently killed, of course, but they

are almost always young hands who are learning. I saw one such make a narrow escape a few months ago. He ran from an elephant and climbed a tree; the elephant butted the trunk and the man fell down, but his pursuer was so astonished at the sight that she fled at once. Sometimes drives are conducted by torchlight, and these seldom fail, owing to the elephants' fear of fire. The scenes on these occasions are exciting beyond description."

Dogs in China.—Dogs in China are chiefly despised except as house-watchers. A black dog with yellow eyebrows is valued as a first-rate house dog, but a white one with black eyebrows will bring bad luck to his owner, while a black dog is the king of his race. A "lion dog"—belonging to the small shaggy northern breed—will bring good fortune; while the only real Chinese canine pet is the "sleeve dog," so called from being small enough to lie in the capacious Celestial sleeve. Retrievers seem to be unknown, while greyhounds are lanky and slow. Amongst the most common canine names are "Jewel," "Pearl," "Blackie," "Black Dragon," and "Yellow Ear."

Bee-keeping in Paris.—It is not generally known that among the industries of Paris the keeping of bees is one that is much practised, and frequent complaints have been made to the police about the nuisance thus occasioned. One inhabitant alone in the 19th Arrondissement keeps from eight to nine hundred hives; and there are a great number to be found in the 13th Arrondissement, near the goods station at Ivry. Valuable

as is the possession of bees to the owners, there is no question but that they do a great deal of damage in various directions. At the Say sugar refinery, for instance, it is calculated that the damage amounts to 25,000fr. a year; for a whole jarful of syrup will be completely emptied in less than a couple of hours, and two or three bushels of bees are taken or destroyed within the day. The workmen, who are obliged to follow their occupation bare to the waist, suffer terribly from these little pests, and frequently get badly stung.

The Eccentric Habits of the Cuckoo.—These, which have long been a subject of comment among naturalists, were brought forward during the summer of 1880 by two correspondents of the *Live Stock Journal*, one of whom wrote:—"Last week I shot what I thought at the time was a sparrow-hawk, but upon examination it proved to be a male cuckoo, and tightly in its claws was a cuckoo's egg, which it retained some time after it was shot. I believe the supposition that the bird carries its eggs about in that way is a much disputed point; but I cannot but after this regard it as a positive fact." The second correspondent, however, did not hold the same theory, as he stated that "no doubt the male cuckoo had been pilfering a small bird's nest, which these birds are very fond of, and by chance came upon a cuckoo's egg deposited therein, and being disturbed, it flew away with the egg in its claws, when it was shot, and in the death struggle (convulsion) the egg was firmly clenched in its claws. I never

knew cuckoos to carry their eggs, but I have watched them pilfering and sucking small birds' eggs many a time, and carrying the shells considerable distances from the nest plundered."

An Unfortunate White Whale.—The Duke of Sutherland, in the spring of 1880, presented to the Museum of the Royal College of Surgeons the skull of a white whale (*Delphinapterus leucas*), taken alive near Dunrobin, which showed a most remarkable evidence of an old extensive injury and subsequent recovery. This cetacean has been but very rarely observed in the British seas, and there would seem to be but one other recorded instance of one having been caught alive. The specimen in question was, writes the Rev. Dr. Joass, of Golspie, found close to the salmon nets near the Little Ferry, about three miles to the westward of Dunrobin, on the 9th of June, 1879. It was caught by the tail between two short posts to which a stay rope of a net was fastened, and a salmon of 18lb. weight, which was supposed to have been the object of its pursuit, was found in front of it. It measured 12½ feet in length. In its efforts to escape it had broken its back between the third and fourth lumbar vertebrae, and it had a recent wound on the front of its head, nearly five inches long and three broad. It was seen two days before its capture, and the

fishermen, seeing it approaching against the ebb, took it for a ghost. Professor Flower, in exhibiting the prepared skull to the Zoological Society of London, stated that the skeleton showed that the whale had been a perfectly adult animal, that the atlas had been dislocated off the occipital condyles, and this completely so, and the bones had afterwards become firmly fixed by deposits of new bony matter in such a way as to enormously narrow the aperture for the passage of the spinal cord. There was no appearance whatever of any disease of the bones, and there could be no reasonable doubt but this dislocation was the result of accident. It is certainly difficult to imagine how such an accident could have happened; such a dislocation is often brought about by a fall on one's head, but aquatic animals are not liable to such a catastrophe—even, thinks Professor Flower, a violent collision of the head against a rock or ship could scarcely have brought it about. It seems marvellous that after such an accident the unfortunate whale could have contrived to pursue and capture living prey. For a time it would almost seem certain its general powers must have been interfered with. After recovery its head was fixed quite awry on its body, and this may account, in some measure, for its wanderings so far from its natural home and for the facility of its capture.

III.—GEOGRAPHICAL NOTES AND TRAVELLERS' TALES.

The Great American Desert.—Many millions of acres of land in the far West are almost entirely without value unless they can be irrigated by water supplied by artificial means. The arid region of the United States embraces 900,000,000 acres, lying in the Territories of Arizona, Dakota, Idaho, Montana, New Mexico, Utah, and Wyoming, the States of Colorado, Nevada, California, Kansas, Nebraska, Oregon, and Texas, and the Indian territory. Not 1 per cent. of this vast area has been sold. It has been ascertained that about 200,000,000 acres are mountainous land, upon which agriculture cannot be successfully carried on, even with an abundance of water. Of the remainder, 200,000,000 acres are lava lands, covered with cinders, &c., lands without soil or vegetation, and desert plains of drifting sand. On the greater part of the 500,000,000 acres not included above, valuable crops can be raised by the aid of water. By spreading the water of streams over the land while the crops are growing, several thousands of acres of this area have already been reclaimed, but these methods can be applied to not more than 15,000,000 acres. There remain 485,000,000 acres which are now used only for pasturage, and on which the vegetation is so scanty that they are almost worthless. It has been shown that the

introduction of water is all that is needed to make these lands fertile. Government has been recently asked to provide for the sinking of two artesian wells east of the Rocky Mountains, and three west of the Rocky Mountains, as an experiment towards the solution of a great problem—the reclamation of what used to be described on maps as the Great American Desert.—*New York Times*.

Sounding Niagara.—A party of United States engineers have recently taken soundings of the Niagara river below the falls. It was a work of great difficulty to approach the falls in a small boat. Great jets of water were thrown out from the falls far into the stream, and the roar was so terrible that no other sound could be heard. The leadsmen cast the line, which gave 83 ft. This was near the shore. Further downstream a second cast of the lead told off 100 ft., deepening to 192 ft. at the inclined railway. The average depth of the Swift Drift, where the river suddenly becomes narrow with a velocity too great to be measured, was 153 ft. Immediately under the lower bridge, the whirlpool rapids set in. Here the depth was computed to be 210 ft.

A Relic of Columbus.—From Martinique comes the news of an interesting antiquarian discovery, in the shape of the anchor of the

ship in which Columbus sailed on his third voyage to the new world. It is well-known that, in 1498, his little fleet came to anchor at the south-west extremity of the island of Trinidad, called Arenas Point, and that during the night the ships encountered great danger from a tidal wave, caused by the sudden swelling of one of the rivers that empties itself into the Gulf of Paria. The only damage suffered, however, was the loss of the Admiral's anchor. This has recently been found by Señor Agostino, while excavating in his garden at Point Arenas. The anchor weighs 1,100lb., and was at first supposed to be of Phoenician origin, but careful inspection revealed the date 1497 on the stock. The geological conditions of the ground in which the discovery was made bear out the conclusion that the anchor is a relic of Columbus.

Unexplored China.—An agent of the China Inland Mission, Mr. G. F. Easton, has recently been journeying to the remote province of Kan-Suh, on the north-west border of China, a region most of which has hitherto been unexplored. Mr. Easton's head-quarters are at the city of Tsin-Chan, and from that place he writes in April and July, 1879, giving some account of what he saw during his travels. Away near the western border of the province, is the new city of Tao-Chan, on the approach to which things begin to put on an aspect different from that presented in China proper. The houses have flat roofs, and many of them an upper storey. The women are very coarse, though healthy; stalwart, with red faces and large

feet, wearing a coarse garment coming a little way below their knees. Their hair is parted in the centre a little way and then divided into two partings over the sides of the head, like the letter Y, the hair hanging loosely over the ears like that of many European women, that of young girls often hanging over their eyes as well. The women seek to do most of the work.

Of all the desolate and ruined cities that Mr. Easton has seen in China, none equal, he says, Tao-Chan new city. Inside the walls, containing an immense enclosure, there is nothing but a massive heap of ruins on every hand; not a street in the city. The city was built within the last 20 years, and is said to have had a large population of "Fan-tsz," but it was destroyed by the Mohammedans some 16 or 17 years ago. These "Fan-tsz," as the border-tribes here are called, give the Chinese authorities much trouble; they are allowed to appoint one of their own number to act as their immediate governor; and in the city of Tao-Chan the sub-prefect is called the prefect of the "Fan-tsz."

Later on Mr. Easton came into close contact with the Fans and found them exceedingly hospitable; they reminded Mr. Easton of the Welsh, and cannot enjoy their food without milk. Mr. Easton's last journey was to Sining-Fur and other cities. This lies beyond Shun-hwa-Ting, on the banks of the Yellow River. After remaining ten days at Sining-Fur, Mr. Easton returned by way of Mén-peh, Lan-Chan, Tihtao-Chan, and Kong-Chang-Fur.

Some of these cities and others referred to by Mr. Easton do not occur in any European map—English, French, Russian, or German ; but they are placed in the Chinese maps, published in book form in Wu-Chang. In the neighbourhood of the Yellow River Mr. Easton found himself among the Sah-la. In appearance and habits they differ little from the Chinese, but they have a distinct language of their own, which bears no affinity to the Chinese. They are entirely Mohammedan. He also met with a few Tu-ren, called the Tu-li tribe by Europeans ; they, too, are entirely Mohammedan ; their language is a distinct one, but there is often a strong resemblance between it and Salah, or between it and Chinese.

At Si-ning Mr. Easton met Count Szechenzi, the Hungarian nobleman who was determined to force his way into Tibet on the track of Colonel Prejewalsky, but who was compelled to turn aside and proceed to Burmah, and who is now in Calcutta. With the Count were two men of science as his assistants. Mr. Easton states that Cameron, the African traveller, was also expected on an exploring journey. The altitude of Si-ning-Fur is 8,600ft., and of Ts'ing-hai (Koko Nor), 10,500ft. The correct position of Si-ning on the map is latitude $36^{\circ} 33' 32''$ N., longitude $102^{\circ} 24' 35''$ E. Five Germans arrived in Lan-Chan to commence woollen and clothworks ; but the enterprise seems to have been a failure, one of them having committed suicide. The wool is bad, and it is difficult to get machinery up. There is a Roman

Catholic bishop at Lan-Chan, who has been there for 14 years. There are other priests about the district, who all wear the Chinese dress and form a society by themselves.

The Sahara.—At a meeting of the Paris Society of Commercial Geography, in the beginning of 1880, M. Masqueray, the Saharan explorer, gave some interesting information concerning the land of Adrar, in the Western Sahara. This he derived from three pilgrims on their way to Mecca, who had been plundered in the desert, and supplied with funds by the French Government in Algiers to continue their pilgrimage. On their return they have promised to conduct the French explorer to their country. Adrar, or Aderer, presents two or three of the chief aspects of the Sahara, which is by no means the universal desert at one time supposed. In the south-west are long bands of sand, not exceeding eight days' march in width. Adrar-Temar, the country of the travellers, is placed like a long and narrow island between two of these bands of sand. It is an almost level region, slightly elevated above the sands, which tend to encroach upon its borders. Intermittent streams are found in the country, and there are numerous towns or large villages, containing a considerable population. The three pilgrims represent their country as covered with gum-acacias ; and ostriches greatly abound. The most important commercial fact in connection with Adrar is the existence at Ijl of an immense deposit of rock salt, which, as we advance towards the country of

the negroes, becomes the most valuable article of trade. Tichu (? Tishit), some days' journey to the south-east of Ijil, is the principal market for the trade in salt, for which slaves are the principal exchange. Three blocks or slabs of salt two mètres long by one broad represent the value of a man. At Timbuctoo a piece of this salt the size of a sandal will purchase a man. "We have little to offer to Europeans," said the three Adrarians, "but we have many wants, and for a long time we have obtained European manufactured goods with great difficulty." Trade, in fact, in the Western Sahara is carried on in the following way:—In Morocco, especially in the south, are numerous markets supplied by England, and conducted by Englishmen, or natives in their service. The goods which are sought after in these depots are cottons, various kinds of textures, powder, arms, and even burses.

The religious tribes of Adrar and those who live between that country and the sea go to Morocco for a stock of these articles, and slowly return to Tishit, selling as much as possible *en route*. In Adrar they get rid of the remainder of their merchandise. Some return to the depots, others obtain camels and salt, and proceed southwards to the country of the negroes, where they exchange salt and camels for slaves. This trade is very profitable. For two pieces of cotton 42 mètres long, and value about 16*s.*, a complete male ostrich skin can be obtained, worth in Paris from £640 to £800.

For three pieces a fine camel or seven or eight fat sheep can be bought. The three Adrarians proposed that a French factory should be established somewhere on the coast between Cape Blanco and Cape Barbas, thus turning some of the profitable commerce towards France, and enabling the Adrarians to avoid the difficult journey to Morocco.

Recent Assyrian and Babylonian Research.—Mr. Hormuzd Rassam read a paper on his last explorations in Nineveh and Babylon before the Victoria Institute, in February, 1880. Mr. Rassam, who regards himself as a native of Nineveh, shared in Sir Henry Layard's early labours and triumphs at Kouyunjik, the acknowledged modern representative of the ancient Assyrian capital, and from 1877 he has twice conducted explorations in the same regions on behalf of the British Museum. It may be added that he has again consented to resume his task under the same auspices, and hopes to start on his new mission armed with the Sultan's firman. As was natural, great prominence was given in the paper to the author's discovery, at Balawat, of the famous bronze gates and temple dedicated to the God of War by the Assyrian king Assurnazirpal, father of Shalmaneser the Great, who bears that title in virtue of the campaigns and triumphs which the bas-reliefs, now in the British Museum, record.

At Nimroud, which the Assyriologists identify with the Biblical Calah, Mr. Rassam found, below the north-east palace, the remains of a more ancient palace

containing sculptures which had been brought from the centre palace, belonging to the time of Tiglath-pileser, or Shalmaneser ; also two detached statues dedicated to the god Nebo, all of which are now in the national collection. Last year at the same site he discovered, not far from the north-west palace, a temple built by the same founder, but so thoroughly wrecked that no trace was left of the actual walls. Even the beautiful enamelled tiles, which must have adorned the ceiling, were so broken and scattered about that, although more than a dozen large baskets were filled with the fragments, he was not able to piece together a single perfect example for the British Museum. The only objects to be found whole and standing in their original positions were a marble altar and what seemed to be a vessel let into the floor of the temple to receive the sacrificial blood. There had been marble seats also for the ministering priests ; and besides these were pieces of a very handsome tripod, round and square pillars of marble and stone, with some hundreds of inscribed bricks, and about 12 marble platforms. These platforms, from the hardly decipherable inscriptions, are thought to have been dedicated to so many different gods.

At Kouyunjik he discovered the handsome decagon cylinder, now among the choicest treasures of the British Museum, running to nearly 1,300 lines of cuneiform writing, and recording a score of years of King Assurbanipal's annals, an elaborate monograph on which annals, as known before

this discovery, was one of the late George Smith's greatest Assyriological works. In speaking of his discoveries at Nebbi Younis, which were not very considerable, he mentioned that this shrine of the "Prophet Jonah," half a mile from Kouyunjik, is to this day called Nineveh in official documents.

In this portion of the paper much interesting information on the ethnography of the region, especially as affected by religious differences, was imparted. As to Babylon, it was not until a year ago that Mr. Rassam was able to begin digging there. Having left some workmen to push on his trenches at Kala Shergat, either the Resen or Assur of Scripture, he reached the site of Babylon. To one section of its ruins, he stated, the name Babel still cleaves ; at Imjaileeba was the palace of Nebuchadnezzar ; and Umran with Jimjima looked as if they had been occupied by the royal household. Save the Birs Nimroud, of whose vast masses of vitrified relics a most graphic account was given, there was, on the Syrian side of the Euphrates, nothing beyond a faint tracing of some walls to show the extent of the city's western limit. At the mound of Babel he uncovered four exquisite wells of red stone placed parallel to and within a few feet of each other. These wells, 140ft. high, he believes, must have supplied the famous hanging gardens. Imjaileeba he did not find virgin soil. He accordingly soon abandoned it, but Omran and Jimjima, judging from the contract-tables and other inscribed terra-cottas found there,

must have been covered with the royal mint and the banking establishments of Babylon. Probably his most important discovery hitherto among these ruins was the cylinder already deciphered by Sir Henry Rawlinson and found to be the official record of the taking of Babylon by Cyrus.

Scaling South American Heights. — Early in January, 1880, Mr. E. Whymper, of Matterhorn fame, successfully accomplished the ascent of Chimborazo, the loftiest mountain in the Cordilleras of Ecuador. He took ten days in getting from the Rio Bamba, two-thirds of the way up to the summit, and the difficulties encountered were greater than was expected, owing to the wind and the rarefaction of the air. On the top of the mountain the thermometer showed a temperature of 11° F. There is no crater at all, but two peaks, both of which Mr. Whymper ascended; the higher one was at an elevation of 21,982 feet above the sea-level, or nearly 12,000 feet above the valley of Quito. Mr. Whymper made some other interesting ascents in the beginning of 1880. He stayed twenty-six hours on the summit of Cotopaxi, in Ecuador at an altitude of 19,500 feet, which he believes to be an experiment altogether unparalleled, and Corazon, Sincholagna, and Antisana, finding the ascent of the last-named mountain the most difficult of all. He was accompanied by two Swiss Guides, and the whole party quite ceased to be affected by the rarefied air, and could be lively at 19,000 feet. Mr. Whymper, however, found the Ecuador climate very unfortunate

for mountaineering, for as a rule the only fine time of the day is from 6 to 7 a.m., the remaining hours being misty.

Mr. Whymper's Recent Ascents of South American Mountains. — The French Vice-Consul at Guayaquil, under date La Cocha, May 24, sends to the Paris Geographical Society some interesting details of the recent ascents of several South American mountains by Mr. Edward Whymper, to which we have referred in the preceding paragraph. The Vice-Consul, after expressing his unbounded admiration for Mr. Whymper, refers to his first "colossal ascent"—that of Chimborazo, and to the fact that the lungs of himself and companions were not adapted for breathing the rarefied air of such altitudes. Mr. Whymper had the courage to "suffer" at a height of 16,000ft for a whole week, at the end of which time his forces revived, and on January 3, at 5 p.m., he reached the summit, 20,600ft. Altogether, with his men, Mr. Whymper sojourned for 18 days on the slopes of Chimborazo. On the summit, in spite of the intense cold, he found the snow quite soft.

His next ascent was that of the volcano of Cotopaxi, where he encamped at an altitude of 19,500ft., with the thermometer 20° below zero Fahrenheit, under a terrible wind and a hailstorm which covered the cone with a thick layer in a few minutes. The heat of the ground was such that the hail melted in a few minutes, and the indiarubber tent began to give way. During that night Mr. Whymper went to the edge of the crater, and next day he took the angles with a theodolite.

On March 10 Mr. Whymper was at Antisana, at a height of 18,750ft. He told the Vice-Consul that this ascent was the most difficult he had made. He was blinded by the terrible glitter of the snow. When the thick mists dispersed he tried the ascent. An immense crevasse on the route was spanned by a bridge of snow, which at great risk Mr. Whymper succeeded in crossing.

On April 4 he reached the summit of Cayambe, at a height of 19,250ft. This is the only great mountain situated exactly on the equator. This ascent Mr. Whymper considered easy ; he was able to advance at the rate of 1,000ft. per hour.

On April 17 he found himself on the summit of Sava-Urcu, 15,400ft. This was the most disagreeable of all Mr. Whymper's ascents. Before being able to attempt it, he had to undergo a torrential storm of rain for 70 hours. He told the Vice-Consul that the ground was like a sponge, and he made the ascent through a thick mist, which prevented him from seeing the summit, compass in hand. His men stuck reeds in the ground, at distances of 100ft. There are glaciers in the Saraurcu, and torrents rush down its eastern side.

On April 24 Mr. Whymper reached the summit of Cotocache, the centre of the terrible earthquake of 1868, which cost the life of 50,000 Ecuadoreans. He saw the lava streams, but not the actual crater. His ascent of 16,200ft. was rendered terribly dangerous by one of those awful tempests for which the region is noted. Mr. Whymper, after a

few days' rest, was to set out from Quito for Iliniza, Altar, and Carihuairazo, and he dreamed of attempting Chimborazo a second time.

Recent Travels in Trans-Jordanic Palestine.—A paper on "Recent Travels in Trans-Jordanic Palestine" was read by Mr. Laurance F. Oliphant, before the British Association, comprising notes of a journey undertaken during the Spring of last year through the provinces of Jaulan, Ajlun, and Belka to the east of the Jordan. The whole country traversed was, excepting in its eastern sections, either pasture, wooded, or arable land, and capable in the highest degree of development, while there could be no doubt that in the unexplored mountainous region traversed by the Upper Yabbok ruins remained yet to be discovered and sites to be identified which would contribute for some years to come to make the whole of this region, already so replete with historical association, a most interesting field of research.

The Discovery of the Sources of the Niger.—The *République Française* gives some particulars of the discovery of the sources of the Niger. MM. Zweifel and Moustier traversed the Hokko and Limbah countries, which, covered with forests on Winwood Reade's visit ten years ago, was now found very little wooded, the demand for the oily almonds of the palm tree having induced the natives to plant oil palms in the place of forests. At Falabah, a Koranks mission arrived a day after themselves, bringing with it the King's brothers, whom they

had released, thus effecting peace between the two tribes. This mission told the explorers that the Niger passed between Mount Lomat and another mountain, and that its three sources, the junction of which formed a small lake, were two days' march from the latter. After many dangers and privations, the travellers found the main source near the village of Koulaks, on the frontier of Koranks, Kissi, and Kono, its native name being the Tembi. The invasion of an army of blacks from Houssa, said to be 15,000 infantry and 10,000 cavalry strong, the meeting with whom would have involved death or captivity, as also famine, obliged the travellers to abandon the idea of entering the Sangara country, on the right bank of the river; but they are confident that the Tembi is the longest of the three streams mentioned by the Koranks, and consequently the origin of the Poliba or Upper Niger.

Relics of the Franklin Expedition.—The Franklin Search Expedition, under the command of Lieutenant Schwatka, returned to New Bedford, Massachusetts, in the close of September, 1880. They had discovered and brought southward relics of the two British ships *Terror* and *Erebus*, which sailed from London, under Sir John Franklin, in May, 1845. The expedition successfully withstood the greatest amount of cold ever encountered by white men. During 16 days of a sledge journey extending over a period of 11 months, the average temperature was 100° below freezing point.

In 1879, the expedition made a com-

plete search of King William's Land and the adjoining mainland, travelling by the route pursued by the crews of the *Erebus* and *Terror* in retreating towards Back's River. They burnt the bones of all remaining above ground, and erected monuments in memory of the dead. Their researches have established the fact that the records of the Franklin Expedition are beyond recovery. They have also learnt that one of Sir John Franklin's ships drifted down the Victoria Straits, and was unwittingly scuttled by the Esquimaux, who found it off Great Point in 1849. The expedition have brought away the remains of Irving, the third officer of the *Terror*. From each spot where graves were found, a few tokens were selected which may serve to identify those who perished there. They also secured a board which may be of use in identifying the ship which completed the North-West passage.

Pharaoh's Army in the Red Sea.—At a sitting of the French Academy, upwards of five years ago, M. Lesseps stated, upon the authority of the reports made by his engineers, that "at the time the Israelites left Egypt, under Moses' leadership, the ebb and flow of the tides of the Red Sea reached up to the foot of the Saragaim, near Lake Timsah." If this be correct, it follows that the spot where the Israelites crossed the Red Sea was situated, not to the south, but to the north of the present extremity of its northern arm. In his paper, *Les Mondes*, Abbé Meigne has traced Israel day by day, in accordance

with these new *data*, and he asks the whole Christian world, since the spot is now known where the Egyptians were swallowed up, with "the horse and his rider," chariot, and everything, to subscribe the requisite funds to enable excavations to be made and "the relics of the army overcome by the Almighty himself to be brought to light." The learned Abbé will undertake the work, if he succeeds in getting together 300,000f., "because the finding of the remains of Pharaoh's army would be a powerful reason in favour of the truth of the Holy Scriptures."

Alaska.—Captain George W. Bailey, of the United States Revenue Marine Service, was instructed to make, in the summer of 1879, and did make, a careful inspection of Alaska and its resources. His report, which has now been published by the Treasury Department, is truly described by a New York journal as "a gloomy document." He himself was lost overboard in the return voyage. His report states that it is folly to talk about a large population getting support from the natural resources of the country north and west of Sitka. In the south-eastern part of the territory hardy vegetables can be raised, but not in sufficient quantities to support a large population. The grass, beautiful in summer, is covered with snow the greater part of the year; the mists, fogs, and want of sunlight render it almost impossible to cure it in any part of Alaska. There is plenty of timber, but the trees are so small and knotty that lumber sawed from them would not be

saleable in San Francisco. The coal taken from the mines is not worth enough to pay for its transportation to market. It is entirely unfit for making steam. Gold-bearing quartz has been found near Sitka, and the reports of it are encouraging. The principal wealth of Alaska is in furs and fish, but the prices paid for fish have been so reduced that this industry was almost unprofitable last year. Captain Bailey found the population of the ports and settlements a little over 9,000, above 8,500 of whom are Aleuts, Indians, or Creoles; besides these there are about 5,000 savages in the interior, and another 5,000 are Esquimaux, who live north of the peninsula and on the border of the Arctic ocean. The people are described as living from hand to mouth. Their food is fish, and when they have money they spend it upon drink.

Captain Bailey, speaking of the Creoles, observes that they cannot be induced to work or to catch fish for others. They catch fish only when they are hungry, and upon these and a few potatoes they barely live from year to year. The aborigines of the interior are a savage and treacherous race. A schooner called at St. Lawrence Island in September, 1879, and found all the people dead at three of the settlements on the island. These people lived in the summer on fish and game, and in winter on seal and walrus. The latter they caught on the ice. In the spring of 1879 the ice broke up early, and then remained packed against the island, so that they could catch neither fish, nor seal, nor walrus. They therefore died of starvation.

Captain Bailey was accompanied by Assistant-Surgeon Robert White, who has written an interesting report upon the diseases and physical condition of the inhabitants of Alaska. These affections, the climate, their peculiar food, and the unhealthy atmosphere of the huts in which they live render the natives unable to withstand acute disease, and make the death-rate very high in some localities, even from 50 to 80 per 1,000 on the Seal Islands. The native doctors use sorcery and incantations alone. Cremation of the dead is practised by the Indians near Sitka. The Aleuts — Indians of the islands — have diminished from nearly 20,000 to less than 4,000 since the Russians occupied the country, yielding to the superior race in accordance with the natural law. Dr. White describes the habitations of the Indians of the islands and the mainland, and the description leads one to wonder that the death-rate is not still greater than that which he has mentioned.

The Discovery of the North-East Passage.—At a meeting of the British Association, Lieutenant Temple, R.N., read a paper on the discovery of the North-East Passage by Professor Nordenskjöld. He said the remarkable voyage of Baron Nordenskjöld was undoubtedly the most important geographical achievement of the year. In recapitulating the advantages likely to accrue from the establishment of a regular trade between Europe and Siberia, he gave an outline of Nordenskjöld's Arctic career up to 1876, and described the voyage of the *Vega* in

some detail. Several foreign vessels specially built for the purpose were actively engaged at that moment in kindred explorations, and the steamer *Nordenskjöld* was attempting the North-East Passage in the inverse direction. He also mentioned with great pleasure that the sailing directions for the coast of Norway, to which he alluded at last year's meeting of the British Association, had now been published by the Admiralty, while some of the Norwegian charts were in course of preparation. The publication of this work with the necessary charts would, he trusted, fill up the gap which had hitherto existed for us in the new commercial highway, and British seamen would be able to take their share in the establishment of a regular trade route between Europe and the mighty rivers of Northern Asia, by means of which the vast but hitherto pent-up wealth of Siberia would find a natural outlet to the great commercial centres of the civilized world. The discovery of the North-East Passage might altogether be regarded as the most completely successful Arctic voyage that had ever been made, and the brave Northmen had covered themselves and their country with imperishable glory.

Admiral Sir Erasmus Ommanney said the greatest praise was due to Lieutenant Temple for his pleasing and complete narrative of this unrivalled voyage. Like the first voyage of the renowned Columbus when he discovered the New World, Nordenskjöld will also be handed down to posterity with imperishable renown as the first navigator who made

the North-East Passage, and carried his ship successfully from the Atlantic to the Pacific, along the Arctic shores of America. Nordenskjöld, profiting by his great experience, selected a vessel most suitably adapted for his object, so successfully accomplished. He could enter into the feeling of disappointment which this great voyager experienced when his career was checked as he neared Behring's Strait by a narrow neck of ice, which compelled him to winter. The absence of icebergs along this coast was remarkable, and tended to prove that there was no high land lying to the north of Siberia. They must not lose sight of the persistent efforts of the Russians, who, for 150 years, had tried to effect this passage by constructing boats on the Siberian rivers, and made many unsuccessful voyages along the coasts, and the success which had attended the voyage of the *Vega* could not have been accomplished by sailing vessels. Steam propulsion had been in this case the great agent of success. Judging from former experience, and knowing the risks and uncertainties of Arctic navigation, he did not wholly accept the sanguine idea that they could navigate with certainty every year these Siberian rivers with impunity; and without at all detracting from the merits of this voyage, he was of opinion that the season was peculiarly favourable to navigation. They could not compare the privations of this expedition with those of our Arctic voyagers. In this case the sun was not below the horizon during winter; and they had the advantage of intercourse with natives, and enjoyed

supplies of game and fresh food during the spring.

Through Central South Africa.

—A paper, giving details of a journey in the year 1875 through central South Africa from the Diamond Fields to the Upper Zambesi, was read before the Royal Geographical Society, in January, 1880, by the author, Dr. Emil Holub. He said that he directed his course by Christiana, the Hallwater Farm, Flerkfontein, Driefontein, and Houmainsflei, towards the chief village of the Hartz River Korans, called Mamusa. Having crossed the southernmost independent Bechuanaland kingdom, he entered that of the Barolong, ruled by Montsiwe. Between the Hartz River and the Molapo he found a great number of salt pans, forming the southern portion of an immense chain of salt pans and salt lakes, extending from the Orange River towards the Zambesi in a straight line, ending about 100 miles south of the junction of the Chobe with the Zambesi. He found the king in Molema's town sitting in judgment on a case of poisoning, and was treated well by him. From Molema's town Dr. Holub took an easterly direction, partly in order to explore the interesting valley of the Upper Molapo, partly that he might ascertain the boundary line of the Transvaal Republic in that direction.

To give in a few words the most characteristic features of the tribes among whom he travelled, he would say that the Batlapins, who could do a great deal in agriculture, and could well supply the Diamond Fields with grain, appeared not to care much for

work, but were greatly given to the vice of drunkenness ; these people were not to be relied upon. The Koranas had accepted all the white man's vices, but none of his virtues, and from that cause and from their never doing any work they are gradually dying out. The Barolongs were, next to the Eastern or Shoshong Bamangwatos, the best of the Bechuana tribes. To some extent they were hunters, but they were also great agriculturists, and cultivated our wheat and imitated our style of European houses ; and as, owing to the measures taken by the present Government at the Cape, guns and ammunition could no longer be taken into the interior, they would be all the more likely to take to agriculture, and to improve both bodily and mentally. That was the more probable, as they were ruled by a man of good disposition, who had shown true love and esteem for the English Government in South Africa.

From Zeerust he visited Linokana, where a German missionary, Mr. Jenson, was settled, who understood agriculture, and had set such a good example to the Baharutse natives among whom he lived that they were now the wealthiest natives in the interior. On the banks of the Limpopo he met a great many Dutchmen, who, being dissatisfied with President Burger's régime, congregated there for an expedition into Damara Land to try and establish a new republic there. His attempts to persuade them to give up their intention was not listened to, and their subsequent deplorable fate he had al-

ready described in the *Diamond News*, published at Kimberley. They were unable to obtain any good ground for a settlement, and numbers of their cattle perished.

The author went on to say that the Eastern or Shoshong Bamangwatos were the best in character amongst all the Bechuana tribes, and their chief, Khama, was a gentleman, the first gentleman-native he had met with as a native ruler, or could hear of from others. He tried to abolish the heathen customs, differing thus from Sechele, though the latter had become a Christian since Dr. Livingstone's visit, and had abolished not only the liquor trade but also the importation of liquors. He could, if desired, bring proof of his great ability, his sincerity in doing good, and his exemplary management of the affairs of his kingdom. It was a pleasure to him to say that his character had been formed by the influence of a white man, the most experienced missionary in South Africa — namely, the Rev. John Mackenzie, who was much liked by those of all creeds who had had opportunity to deal or converse with him. Though without any office or employment under the British Government, he had during his residence at Shoshong done a great deal to the honour of Great Britain in thus influencing in a moral way a native king on whom the English Government in all its dealings could fully rely. The Western Bamangwatos, though far behind their eastern neighbours, seemed lately to be doing their utmost to gain a position like theirs, and they might hope

that, as their king was young, he might be led to become a good ruler and a trustworthy man like his friend Khama.

The author had visited Shoshong before on his second journey, and here, as in all other towns, he exercised his profession among the natives (and he had often thanked Providence that he had chosen this profession), for by so doing he not only gained the confidence of tribes and chiefs and was better treated, but gained opportunities *ad libitum* of studying the native character and customs at his leisure. The distance traversed between Linokana and Shoshong, including many deviations for the purpose of exploring interesting places, was 363 miles. After a fortnight he left Shoshong, crossed the interesting Bamangwato Mountains by the Unicorn Pass, travelled along the Letloche Spruit (running into the Mahalapse), proceeded to the pits of Kanne, and then further north to the drift of the Luala. On the 30th of July he reached the first tributary of the Zambesi, the Deyklah River, and on the following day arrived at the Valley of Pandama, where a trading station was established, and where he was kindly treated by the traders. On the 6th of October he crossed the Zambesi for the second time.

Through Central China.—One of the most efficient and hard-working of our missionary societies is the China Inland Mission, founded about 13 years ago. From a map of China recently published by this society, we see that the country has been traversed by their missionaries in nearly every

direction, and, besides their own proper work, they collect much valuable information of the country and the people, which, however, we regret to say, seldom is made public. In a recent number of the Journal of the Society, however, is the narrative of a journey made by one of their missionaries, the Rev. John M'Carthy, right west from Chen-Kiang, at the mouth of the Yang-tze-Kiang, through the provinces of Hu-peh, and Sy-Chuen, and south and west through Kwei-Chan and Yunnan to Bhâmo, in Burmah. Mr. M'Carthy describes his journey in a letter to Mr. T. T. Cooper, the late political agent at Bhâmo, who forwarded it to the Viceroy.

Leaving Chen-Kiang in January, 1877, Mr. M'Carthy went by steamer and boat to Wan, on the eastern border of Sy-Chuen, finding the people everywhere friendly. This friendliness was especially noticeable after passing the boundary of Hu-peh, in Sy-Chuen. From Wan, Mr. M'Carthy walked across the country some 260 miles west, to the prefectoral city of Shun-King, visiting many walled cities, towns, and villages by the way. This part of Sy-Chuen is most densely populated; large villages and towns are very numerous, at distances of a little more than a mile or so apart. The people seemed very industrious, and hardly a spot of land could be found uncultivated, the hills up to their very summits being covered with vegetation—wheat, beans, peas, rape, the poppy, and rice being the principal crops. A brisk trade is carried on, cotton, salt, iron, sulphur,

&c., being brought back from Wan in exchange for the above vegetable products. Arrived at Shun-King Fu, Mr. M'Carthy found there was a strong feeling against the Roman Catholics, who had been very numerous.

Coming upon the Yang-tze-Kiang again at Chung-King, Mr. M'Carthy found that Mr. Baber was in the town. Mr. Baber told him that it would be prudent to continue his journey, and Mr. M'Carthy went on, walking most of the way, to Kwei-Yang Fu, in the Kwei-Chan province; it took him 26 days. In this section he found large tracts of land uncultivated, towns fewer, the people more scattered and worse housed and clothed than those previously met with. Wearing the Chinese dress and having nothing strange or novel about him, he had every opportunity of mixing freely with the people. Mr. M'Carthy states that it would be difficult to picture the desolation of a great part of the Kwei-Chan province in consequence of the many years' internal strife. Whole districts have been entirely depopulated, the people being either slaughtered or scattered. The Government, to encourage immigration, instructed the Mandarins to help all who needed it by free grants of land, or loans of money and cattle. The Mandarins, however, look after themselves, and so matters remain in much the same condition from year to year. The poppy was the only plant Mr. M'Carthy saw under cultivation. Opium smoking seemed here to be universal.

At Kwei-Yang Fu, Mr. M'Carthy found the French mis-

sionaries very strong, and their converts numerous. Indeed, all through the provinces of Sy-Chuen and Kwei-Chan their followers must be reckoned by thousands. They have places of worship in all the cities and many of the larger towns, and the missionaries appear to have very considerable influence. At the capital of Kwei-Chan there are two cathedrals, and in some of the shops crucifixes and other things used in worship may be purchased, which of itself would show that their adherents must be numerous. Westwards from Kwei-Yang Fu, desolation and dilapidation were everywhere met with, the only exception being the district and city of Ngan-Shun Fu. The city itself is a populous and busy place, and, next to the capital, the most important city in the province. Thousands of people attend the fairs held monthly outside the walls of what must once have been a populous suburb. Large quantities of opium are taken down to Canton, and even opium finds its way to Shanghai.

Mr. M'Carthy continued to find everything and everybody pleasant and agreeable as he continued his journey through Yunnan province. He never found any difficulties with officials, and never had to appeal to them for help. He stayed ten days at Yunnan Fu, where he met a French missionary, who gave him a glowing account of the climate, which he afterwards proved to be correct. It seems to be the most temperate and bracing climate he has yet experienced in any part of China. The missionary told Mr. M'Carthy that it was well-known that the

former governor had given instructions at first to have Mr. Margary murdered on his journey to Bhâmo, but that it was afterwards decided not to molest him unless he attempted to return. Everywhere there was evidence of the severe struggle through which the province had passed during the rebellion. The people generally are in a deplorable condition, and men and women, especially the latter, suffer from the formation of goitre, some of immense size.

At a later stage of the journey he passed through places where numbers of people were carried off by a disease resembling the plague. From Ta-li to Momien is really the most fertile part of the country. Mr. M'Carthy met on the way with Yang-Ta-jin, the highest military authority of Yunnan. He is now said to be the wealthiest man in Yunnan, as a great deal of the Panthay property has fallen into his hands. He employs large numbers of men to carry cotton from Burmah. Indeed, it would seem that the great bulk of the carrying trade of Yunnan is in the hands of a few mandarins, and this may account for their dislike to see the route opened to others. The people for the most part are delighted at such a prospect; the popular idea seems to be that soon an English consul will be sent to Ta-li Fu to open a foreign store!

Mr. M'Carthy seems to have been induced to continue his journey across the frontier into Burmah solely on account of the perfect friendliness of officials and people, who seem to regard the

missionaries as real friends. He was well received even by the dreaded Kak-yens, and arrived in safety at Bhâmo on the 26th of August. He intended to return, but Mr. Cooper told him that it was forbidden to enter China by Burmah. Mr. Cameron, another missionary, went right westwards from Chun-King to the very border of Tibet, and thence south to Bhâmo. To so enterprising a society one must wish all success. Their missionaries are doing good service in many ways.—*Times*.

Mr. Stanley's African Expedition.—From French sources we have recent information concerning the expedition under Mr. Stanley for rendering the Congo route practicable to commerce. Stanley's first station is opposite the second rapid of the river, above Noki. It is 60 mètres above the river level, on a small plateau surrounded by precipices. Along the northern ridge are the magazines, a movable wooden house, sheds, &c. To reach this height, Mr. Stanley has made a road 400 mètres long. The engineer of the expedition calculates that to reach by land the Yellala Falls, will require the construction of a road 200 kilomètres long, over a rough and difficult country. The Rev. Father Carrie, Superior of the Roman Catholic Mission to the Congo, writing from Landana on December 3, last, gives some further information.

The personnel of Mr. Stanley, the Father writes, is very numerous; besides Mr. Stanley, there is a superintendent, an engineer, a captain, several mechanics, carpenters, &c., in all 20 whites

of different nations—Belgians, Americans, English, Italians, Danes. The expedition has recently been joined by a French naturalist, M. Protche. Many of the Europeans had already succumbed to fever and the hardships of the work involved. The following of blacks consisted of about 100 men, Arabs or natives of Sierra Leone and the Congo. There are five small steamers and several other boats, carts, and machinery for land transport, wooden houses ready to erect, &c. Father Carrie was taken by steamer to Noki, the last European settlement on the river. Thence in a canoe the Father was taken further up, to Vivi, the first station of Mr. Stanley's expedition, on the right bank of the river, about 130 miles from the coast. Four or five miles further up, the first of the Yellala Cataracts is met with. When the Father arrived, Mr. Stanley was away among the mountains in the direction of the great village of Vivi. M. Van Schandel told the Father that Mr. Stanley set out on his excursions and returned without giving notice to anyone. The traveller soon returned, "exhausted by fatigue and covered with dust and perspiration."

While waiting the end of the rainy season, Mr. Stanley is solidly establishing himself in his first station, the basis of all future operations, and maturing his plans for overcoming the difficulties to be met with. These difficulties are so great, that the Father thinks it will take years before the termination of the terrible chain of mountains can part of the hardy settlers who

be reached and the second station established at Stanley Pool, 200 miles distant. Mr. Stanley's intention, we are told, is to ascend the Congo to the Lualaba, where he hopes to find his Arab friend, Tibu Tib. Then he will explore the western part of the Congo, as well as the country on its two banks, attempting, at the same time, to attract the ivory trade to Mboma. Father Carrie fervently prays that the Roman Catholic missionaries may be beforehand with their Protestant rivals in availing themselves of the route which Mr. Stanley has begun towards the interior.

"Iceland and its Resources."—This was the title of a very interesting lecture, delivered on the 28th of March, 1880, by Mr. C. G. W. Lock, the author of "*The Home of the Eddas*," at the Society of Arts. The lecturer combated the general notions regarding Iceland, that it was a "little island in the Arctic regions enshrouded in darkness during most of the year, covered with ice, except where volcanoes, especially Hecla, raised the temperature, and produced 'Iceland moss' and reindeer;" and he showed that it cannot be called "little," as it has an area considerably larger than Ireland or Ceylon, that it is not in the Arctic Circle, that it has no reindeer, and that the "Iceland moss" of commerce is not brought thence. He gave an interesting geographical description of the island, dwelt upon its peculiarities of climate, and then touched upon its history, declaring that colonists from the shores of Britain formed no insignificant

more than a thousand years ago occupied this lone island in the Atlantic, which is shown in the fact that many words in use are identical with British words. He added significantly, for traders who seek new worlds to conquer, "But such ties as history, race, or language can bind are accounted of secondary importance in these mercenary days. The main question is what can be made out of the place. Relatively small though that may be, it is strange to see at our back door an island whose commerce was once entirely in British hands now abandoned to the mercies of Danes, Germans, and French. So long ago as the 13th century, commercial intercourse between the chief ports of England and Iceland was firmly established, and men who engaged in the trade were rewarded with royal subsidies and other favours. According to native accounts, the British trade was matchless; it was the most complete and the most advantageous, and gladly would it be welcomed back."

He proceeded to describe the produce of Iceland, placing first the ponies imported here by an ironmonger of Leith, and used greatly in the Black Country. The sheep he highly praised for their flavour, but held that the wool could be improved. The skin trade, the catgut trade, the fox fur trade, and the industry in eider-down and feathers were described; and the lecturer then entered at length upon the subject of the cod fisheries, one of the most important industries of the coasts.

In dealing with this he spoke of the cod-liver oil manufacture,

stating that the island exported about 10,000 barrels, the fish refuse, which might easily be converted into a highly nitrogenous manure, being left on the beach (like London sewage in the Thames) "to poison the air." He spoke of the shameful abuse of another valuable resource — the salmon fishery; all kinds of barbarous methods of taking the fish having been carried to such an excess as to make the name of "salmon water" an empty mockery, and he said that the Icelanders had yet to learn that much more profit might be gained both directly and indirectly by letting out their streams to English fly-fishers — the one great attraction which the island offers to sportsmen — than by contracting with fish-curers.

He discussed the subject of the sulphur production in Iceland, and exhibited some of the wool work, which especially was of an excellent character. Stockings such as those which were exhibited by the lecturer as the product of Iceland could not be purchased in London, and if they could they would be highly prized in a severe winter. A practically valuable lecture was concluded by attention being drawn to the opening for trade in carrying British products to Iceland and bringing back products of the island.

African Exploration. — An interesting communication was read in March, 1880, at a meeting of the Royal Geographical Society, from the commander of the Society's East African expedition. The letter just received was dated November 9, 1879, at Pambete, a place at the extreme southern

point of Lake Tanganyika. The expedition reached the lake on the 4th of November. Mr. Thomson appeared to have been prostrated by fever soon after his arrival there, and this had prevented him from taking advantage of the departure of Mr. Stewart, of Livingstonia, to send a sketch-map and detailed account of his route.

"The country of Konde (misnamed Uchungu by Elton)," wrote Mr. Thomson, "from which we took our start, lies at the north-west corner of Lake Nyassa, and occupies a deep triangular indentation in the central plateau, the escarpment of which, rising to a height of from 6,000ft. to 8,000ft., bounds it on all sides except the east. Near the lake extends a broad plain of wonderful fertility, with a large population.

"Proceeding north-west, we left the plain and crossed a gently undulating ground covered with trees, and drained by the Jumbaka. When we got to the height of 3,000ft. we entered an extremely broken and ridgy country, forming excellent grazing land, but having few trees, and not well suited for cultivation. The country of Konde is drained by three considerable rivers—the Lufira, which drains through the Ukinga mountains from near Mazote's High Pass; the Jumbaka, which runs nearly parallel with the Lufira, but in the lower grounds; and the Lukuviro, which enters Nyassa, south of the Great Elephant Marsh. The number of feeders of this stream draining from Usafa in a small space is wonderful. In an hour we have crossed six streams, two of them being of

considerable volume. The people of Konde are all Wakinga, who have emigrated from that mountain region owing to internal dissensions. Uchunga, as Mr. Stewart will soon make appear, lies to the south of Konde. The most westerly limit of Konde I place in long. $33^{\circ} 45'$ E., and in lat. $8^{\circ} 22'$.

From this point the extremely steep face of the plateau commences, and we ascended from an altitude of 3,300ft. to 6,500ft. in the country of Nyika. The first two stages took us over highlands with an average height of about 7,000ft., forming good grazing ground, and well wooded in many parts. The highest point reached was on the Munboyia mountains, a range running about W.N.W. and E.S.E., on the top of which the barometer showed a height of 8,180ft. From these mountains the ground descends through barren woodland with few fertile spots till long. $32^{\circ} 45'$ is reached, where the altitude is only 3,300ft. The whole of that part of the Nyika through which our route lay is extremely broken, sustaining a very scant population, who possess a few goats and in some places cattle. There is very little cultivation. The people, however, are a most courageous race, and certainly the most arrogant I have met. There is, however, no cohesion among them, and each little head man of a village has to fight his own battles with Merere's raiders, who constantly harass the country.

To the west, Nyika is bounded by the Chingambo mountains, which, running north and south, rise from 3,000ft. to 5,000ft. with steep easterly face, but sloping

gradually away to the west. These mountains are in longitude $32^{\circ} 45'$ E., and the latitude $9^{\circ} 5'$. But one stream deserving the name was crossed by the expedition, the others being mere rivulets, one or two draining to the Lukuviro, a few south, and the others north-west to Lake Hikwa."

The exact position of this lake, Sir Henry Rawlinson said, was not yet known.

"Crossing the Chingambo mountains," Mr. Thomson's narrative continued, "we entered the country of Inyamwanga, a small country reigned over by a chief called Milla, who, though possessing few subjects, showed more of the potentate than any of the chiefs I have yet seen. The whole country is covered with trees, having only a few grassy open spaces. The land sloped gradually west until we got near the boundary stream Mkaliza, which flows south in about longitude $32^{\circ} 20'$. We here entered the country of Mambwe, which is one of alternate grassy plain and wooded ridge, rising in altitude to a height of 5,000ft. at the chief Kitimba's capital, Mulichuchu. This height was generally maintained until we reached Tanganjika through the hilly country of Ulungu, a narrow strip round the lake.

"The northern part of Mambwe forms a great watershed for streams joining the Lofu and Luguvu, and if our guides were to be believed, a considerable stream called the Wawa flows to Lake Hikwa. The main interest, however, attaching to this region is the existence of a huge spring situate in an angle of the Ulungu

and Uwembe mountains, which gives rise to the main tributaries both of the Lofu and the Luguvu. The latter we crossed a quarter of a mile east of the spring, and we found it to be about 5ft. deep and 12ft. broad. The stream is here called the Saisa.

"From such information as I been able to collect from the natives and my own observation, I cannot but conclude that the rising of the lake is periodical. On all hands I am informed that as a rule it rises from 18in. to 2ft. during the rains, and according to the amount of rainfall so does the water rise. Four years ago there was an excessive rainfall which raised the level of the lake about 10ft., flooding Pambe, and maintaining its height for a month; and to this day the marks on the dead trees, now out of reach of the water, attest the truth of the statement. Trees standing out in the water have been cited as an argument in favour of the theory of a gradual rise; but an examination of them shows that they have attained their present position by the washing away of the soil during these periodical risings. Further observations along the shores will help to clear up the question."

After giving a table of barometrical readings, taken mainly by Mr. Stewart, the fever having unfitted him for work, Mr. Thomson concludes his letter:—"To-morrow I start along the western side of the lake northwards till I reach a good place where I may camp my men, and, taking about 30, push on for the Lukuga creek, passing down the river about 30 miles, and then striking south

through the still unexplored region in that quarter, get back to camp and march for Kilwa, which I hope to reach within six months. I may add that my protractedions have brought me almost right in latitude, but about ten miles too far west in longitude, taking Livingstone's map as correct."

A Chinese Superstition.—When Chuntche, the first of the Manchu Emperors, and the founder of the present, or Tsing, dynasty, ascended the throne of China, he planted a tree in the courtyard of the temple called Tan-chè-ssu, which is situate in the hills a short distance west of Pekin. It is believed that the ruling family will remain in power so long as this tree exists. At present it shows no signs of decay, and has apparently a long life before it; but there is a still more extraordinary superstition attached to it. Saplings sprout out periodically from the root, and with the death of each prince one withers away, while a fresh one appears in honour of the new Emperor. Each sapling bears the same relation to the individual prince that the tree does to the dynasty, and, not unnaturally, the Emperor for the time being watches with considerable anxiety the growth of his particular sapling. The tree is named "the Emperor's tree," and it may be worthy of note that the sapling of the present Emperor is said to be extremely vigorous and flourishing. This superstition finds very general credence, and the Chinese come from considerable distances to make their reverence to this famous tree. Another of the

customs peculiar to the present dynasty is that no Emperor can be buried in the same place as his predecessor. Consequently there are two State burial-places: one at Hsi-ling; and the other at Tung-ling. Chuntche was buried at the former; both Kanghi and Kem Tung at the latter. The present Emperor will also in his turn occupy the same place of sepulture as the two greatest of his ancestors. Pilgrimages are made both to Hsi-ling and Tung-ling; but the latter is held in the greater respect. Wu-tai-shan, where Chuntche was said to have retired, is also visited by great numbers of devotees. Rightly or wrongly, the belief is very prevalent among the Chinese that the present reign is to be a prosperous one, and that much of the glory of the past Manchu Emperors is to be revived under the present ruler, and these superstitions are appealed to as proof positive of the justice of the anticipations.

Researches on the Site of Pergamos.—The researches on the site of the ancient Pergamos, now Bergama, in Asiatic Turkey, undertaken by a German engineer, have resulted in the discovery of over 200 statues and pieces of sculpture belonging to the best period of Greek art. Most of the statues come from a temple to Athena on the site of the Acropolis, and include the altar, a colossal Laocöon, figures of Eros, of two sleeping female figures, of many Roman ladies, of satyrs and tritons, as well as a highly ornamental frieze and base of a pedestal supporting a statue of Zeus, and adorned with representations of the deities of the elements.

IV.—GEOLOGICAL RECORDS.

The Giant's Rattles.—An interesting geological discovery has been made in the neighbourhood of Solothurn. On removing a mass of superincumbent sand and gravel to prepare for some quarrying operations, the rock beneath was found to be quite smooth and intersected with old water channels. The excavation being continued, a number of enormous holes filled with great stones were laid bare. These holes, like those in the famous Gletcher Garten at Lucerne, are due to the action of water, which, flowing through rifts and in the glacier that ages past covered the rock, set in motion the stones beneath, whereby the "Giant's Rattles," as they are called, were hollowed out; but while the rock at Lucerne is sandstone, the formation at Solothurn is hard limestone and quartz.

Pre-glacial and Post-glacial Effects in the North-west of England.—Mr. C. E. de Rance read a paper, before the British Association, on the "Pre-glacial Contours and Post-glacial Denudations of the North-west of England." In it he described the country between the carboniferous hills of the Pennine chain and the Silurian mountains of the Lake district and North Wales. The plains of Lancashire and Cheshire lying at their feet were covered with glacial deposits reaching in one case, near Orms-

kirk, a thickness of 230ft. The deep valleys of the Lake district had obtained their present proportions before the glacial epoch, during which the latter were excavated in the case of Windermere to a depth of 230ft., or deeper than the English Channel between Boulogne and Folkstone; the bottom of the lake being 100ft. beneath the sea-level. In the valleys of the mountain-country numerous glacial deposits were present, having been re-excavated in Lancashire, Cheshire, and Flintshire. The Miocene drift occupied an extensive area, and valleys like those of the Ribble and Sowell, nearly 200ft. in depth, had been excavated. Occasionally it was found that the bottom of the valley was below the sea-level, pointing to the fact that the land must have been higher in post-glacial times—a terrace of post-glacial deposit, covering the glacial area over, and often below the sea-level, consisting of peat. The peat beds were found to an extent in one case of about 70ft., and it was pointed out that an elevation to this extent would connect Lancashire, Cheshire, and much of North Wales, with the Isle of Man.

Underground Waters.—In the section of Geology of the British Association, Mr. C. E. de Rance, F.R.S., read the report on "The Circulation of the Underground Waters in the Permian, New Red

Sandstone, and Jurassic Formation of England, and on the quality and character of the water supplied to towns and districts from those formations." He described the porous character of these rocks and the purity and permanent character of the water supplied by them, each square mile of country yielding 40,000 gallons per day, with an absorption of one-third of the rainfall, with averages 30in. per annum. He pointed out that the great rainfall of the country is all on the palæozoic rocks lying west of the great watershed separating the basins of the Humber and the Severn from those of the Thames and East-coast streams, west of which lie no secondary rocks except the trias. He mentioned the discovery of the Manchester coalfield beds under the new red sandstone at a depth of only 340ft. He referred to the position of the new boring at Bootle for the Liverpool Corporation water-supply as very badly chosen, being close to one of the existing wells. He then showed the gradual attenuation in thickness of the bunter sandstone to a southerly direction against the old palæozoic, ranging from the Belgian coalfield to the Mendips.

Prehistoric Rivers of Egypt.—An eminent savant, Dr. Delamotte, we learn from a French journal, who is thoroughly conversant with the geology and geography of Egypt, gives it as his opinion that the Nile was not the only river which watered ancient or prehistoric Egypt. The country was then watered, according to him, by all the rivers now dried up, and which the Arabs of the desert call *Bahr-el-Abiad*, "rivers

without water," great beds of sand, in which shells had been found long ago. When these rivers were dried up Dr. Delamotte does not pretend to indicate. But as to the geological phenomenon which has led to this drying up, and, as a consequence, the change into a desert of vast fertile regions, Dr. Delamotte believes he has discovered this; and after 20 years of work, he has gone to Egypt to verify the *data* which ought to justify his theory. In prehistoric times, according to him, all the plateau of Khartum, the rise of which is scarcely 16 mètres, was a great lake similar to the Victoria Nyanza and Lake Tanganyika, and from which the Nile issued, as it issues to-day, from its two lakes; but the cataracts were then much higher than they are to-day, and when the river reached them, instead of precipitating all its mass of water on these cliffs of granite and porphyry, it divided into different currents which formed the *Bahr-el-Abiad* of to-day, and which watered the region now changed into a desert. After long centuries, then, the granite and the porphyry of the cataracts were insensibly worn, their level lowered, and immediately the Nile retired from the *Bahr-el-Abiad*, to precipitate its entire volume into the single channel which it follows to-day. But the scientific proof of this is not the sole object aimed at by Dr. Delamotte; he is also of opinion that to fill again the *Bahr-el-Abiad*, and thus to increase ten-fold the arable land of Egypt, it will suffice to raise the cataracts—that is, to establish at each of them a system of dars and locks

The Khedive, it is said, is greatly interested in these fine schemes, and has promised his support to Dr. Delamotte.

Carbonic Acid and Limestone.—Professor W. Boyd Dawkins read a paper before the British Association, on the "Action of Carbonic Acid on Limestone," in which he said that caves in the limestone are to be looked upon as subterranean watercourses, which are produced by the dissolving action of the carbonic acid in the rain-water, and partly by the mechanical action of the streams flowing through them. The insoluble carbonate of lime in the rock is changed into the soluble bi-carbonate and carried away in solution. The additional atom of carbonic acid, however, is in a condition of unstable chemical combination; and if it be removed either by evaporation or by the action of a free current of air, the insoluble carbonate of lime is at once deposited. Hence it is that some caverns have their walls covered with a drapery of stalagmite, and the little straw-like pendants from the roof formed round the edges of each drop gradually become developed into columns of various sizes. The stalagmitic pedestals also rise from the floor, where a line of drops falls from the roof and ultimately unites with the column let down from above. On the surface, too, of the pools, an ice-like sheet of stalagmite gradually shoots across from the sides, and sometimes, where the water is still, covers the whole surface. Admirable illustrations of all these processes are to be seen in the caves of Pembrokeshire, and especially

in the Fairy Cave on Caldy Island.

The rate of the accumulation of carbonate of lime, depending primarily upon the access of water and the free access of air, both being variable, varies in different places; sometimes it is very swift, as, for example, in the Ingleborough Cave, where a series of observations by Professor Phillips, Mr. Farrer, and the author, extending over the years from 1845 to 1873, give the annual rate at .2946 in. It is obvious, therefore, that all speculation as to the antiquity of deposits in caves which is based on the view that the accumulation is very slow is without value. The mountain limestone ravines and passes are to be viewed in the main as caverns formed in the manner above stated, which have lost their roofs by the various subaerial agents which are ever at work, attacking the surface of the limestone. If any of these be examined it will be seen that the tributary caves open on their sides, and, in some cases, the ravine itself is abruptly terminated by a cavern.

The Floor of Europe.—In the presidential address of Professor Ramsay at the British Association (see section XII.), he alluded, in support of his theory of the constant recurrence of glacial phenomena from the most ancient times, to some observations made by Professor Geikie in July last, in the north-west of Scotland. The full details of the observations are just published by Professor Geikie in the last number of *Nature*, and they are of an interest almost exciting. He has

discovered what may well be regarded as the floor of the British Islands and of Europe, got, as they would say in the north, to "the back o' beyond," reached the platform on which all the wonderful and varied superstructure of European scenery has since been raised. In the north-west of Scotland, he tells us, along the seaboard of the counties Ross and Sutherland a peculiar type of scenery presents itself, which reappears nowhere else in the mainland. Seen from the westward or Atlantic side—as, for example, sailing into Loch Torridon, or passing the mouths of the western fjords of Sutherlandshire, the land rises out of the water in a succession of bare, rounded domes of rock, crowding one behind and above another, as far as the eye can reach.

They present the appearance seen in the familiar pictures of the domed houses of the prairie dog. Gray, rugged and verdureless, they look as if they had been but recently thrust up from beneath the waves. The whole landscape is one of smoothed and rounded bosses and ridges of bare rock, which, uniting and then separating, enclose innumerable little tarns. The rocks that have assumed this external contour, the Professor informs us, are the Fundamental, Lewisian, or Laurentian gneiss, which, as Murchison first showed, form the platform whereon the rest of the stratified rocks of Britain lie. The fringe of mammillated gneiss is not, however, continuous, being broken here and there by overlying deposits, sometimes of

enormous thickness, by dark-red sandstone and conglomerate, above which are seen deep piles of white quartzites, limestone and schists. How enormous must have been the age of the underlying Fundamental gneiss may be realised from the fact that it was first buried under several thousand feet of red sandstone, that the area was then further submerged until the vast pile of sediment was deposited out of which the Highlands have been formed; that these sedimentary accumulations — how many thousand feet thick we cannot tell—were subsequently over the Highland area metamorphosed into crystalline schists, and that finally towards the west the ancient platform of gneiss was once more ridged up and gradually bared of its superincumbent load of rock, until now some portions of it have been once more laid open to the air.

There is thus, Professor Geikie rightly goes on to say, a special historical interest in this fragment of the old gneiss country. It is a portion of the earliest surface of Europe of which as yet we know anything—a surface in chronological comparison with which the Alps are of quite modern date. Professor Geikie has studied the curious fragment of primæval Europe, as he calls it, for many years, but it was only during his visit in July last that he succeeded in explaining its peculiar mammillated or domed appearance to his own satisfaction. The surface of the rock, like that of neighbouring rocks of a different class, is marked

by those striæ or scratchings which geologists attribute to the passage of glaciers. These scratchings, however, are of comparatively recent date. The domed structure itself, presenting the appearance of a regular series of *roches moutonnées*, is, he maintains, the result of glaciation of an enormous antiquity, belonging to a period before the superincumbent mountains were brought forth, and when probably the surface of the land consisted almost solely of this fundamental gneiss. As Professor Ramsay said, this must be reckoned as having occurred almost before the beginning of geological time, at a period when geologists have been in the habit of believing that the forces of Nature were considerably different from what they are now. Yet at a period so remote we have here evidence of Europe having been covered by an ice-sheet, the power of work of which was so enormous as to scoop out the land into the mammillated surface still seen in the north-west of Scotland. Our old earth, one would fancy, could then have scarcely lost the memory of the days of her red-hot youth. Professor Geikie's discovery is of very great scientific value.—*Times.*

Volcanic Eruptions and Earthquakes. — According to Herr Fuchs there were in 1879 only three eruptions, none of which were of extraordinary violence. The most notable was that coincident with the appearance of a new volcano in Lake Ilopango, in San Salvador, following on a series of violent earthquakes, in December last. This raises to six

the number of active volcanoes in that State; and there are five extinct. The eruption of Etna, beginning on May 26, was specially marked by an uncommonly long lava stream—16 kilomètres. The preceding earthquakes were not very great. Yet the mountain mass opened in a chasm of rupture 10 kilomètres long, cutting the principal crater. The north-eastern and higher end of the chasm presented the more numerous and larger craters, whence came the great branching lava stream, the central part giving only steam and fine ashes. This eruption ended in 11 days. The third eruption was that of the volcano Merapi, in Java, on March 28. It gave lava and ashes abundantly. Several other Javan volcanoes, as also Vesuvius and a submarine volcano south-west of Iceland, were in a somewhat active state.

Of the 99 earthquakes which came to Herr Fuchs' knowledge only a few were of remarkable strength. On the night of March 22 a violent earthquake was felt in northern Persia for several hours, and destroyed a number of villages; from that date to April 2 (when the last vibrations occurred) some 900 persons perished. The earthquake of April 25, in the Romagna (Italy), was also of unusual strength; the valley of the Senio was most affected, and in Palazzuolo numerous buildings were thrown down. Another very violent earthquake occurred on May 17 in Mexico; the ground movement was observed in all the region from Vera Cruz to the town of Mexico, and in Cordoba and Orizaba great injury was done. On June 29 violent earthquakes

began in a part of China and extended over 30 districts; in this case the phenomenon of huge water-jets spouting up through the opened ground was observed.

The shocks were repeated till the middle of August and many hundred lives were lost. This feature of fountains marked several earthquakes in 1879—*e.g.*, one in Bessarabia in May, which commenced with a detonation like that of a cannon; and one on the lower Danube, from October 10 to 18, when a large fountain and several small jets appeared on the island of Babacay. To the violent earthquakes belong, also, those which preceded the formation of the new volcano in Lake Ilopango.

Of German regions, Carinthia and Carniola were the richest in earthquakes last year. The first earthquake occurred on January 11, reaching through the Lavan valley and much further. On February 2 it was repeated, being strongest in Carniola, and extending over parts of Carinthia, Styria, and the coastland. A third violent earthquake occurred on May 8 on the southern slope of the Ston, between Carinthia and Carniola; it was like a blast in a mine. On October 1, Klagenfurt was the chief scene of an extensive earthquake. Several others of less importance were experienced. Next after this region comes the north-west Rhine region, which since 1873 has been often affected. The south-western Schwarzwald, too, experienced several shocks last year. This district has of late formed part of a large earthquake region, comprising Western Switzerland, Eastern France, and South-Western Germany, the principal

line of action extending from the Lake of Geneva over Basle.

In the German Empire earthquakes occurred on 13 days and at nine different points, as follows:—Buir (Jan. 3 and April 9); Aachen (Jan. 10 and May 26); Schwarzwald (Jan. 26 and Dec. 5 and 22); Lachthal (Feb. 9), the Bavarian-Tyrol boundary (Feb. 17), Gebweiler (Feb. 20), Saxony (March 12), Harburg (Nov. 17), Mühlhausen (Dec. 4). The days of 1879 on which there were the most earthquakes were Feb. 14 (Brusio in Graubünden, Laibach, Arco in Tyrol) and July 2 (Athens, China, Burg, near Greifenberg).

The Comparative Structure of Artificial Slags and Erupted Rocks.—The address in the Geological Section of the British Association, was delivered by the president, H. C. Sorby, LL.D., F.R.S., who took for his subject the comparative structure of artificial slags and erupted rocks.

After a few introductory remarks, the president proceeded:—Much might be said on both the purely chemical and purely mineralogical aspects of the question; but though these must not be ignored, I propose to draw your attention mainly to another special and remarkable class of facts, which, so far as I am aware, have attracted little or no attention, and yet, as I think, would be very instructive if we could fully understand their meaning. Here, however, as in so many cases, the observed facts are clear enough, but their full significance is somewhat obscure, owing to the want of adequate experimental data, or of sufficient knowledge of general physical laws.

A considerable amount of attention has already been paid to the mineral constitution of slags, and to such peculiarities of structure as can be learned independently of thin microscopical sections. A very complete and instructive work, specially devoted to the subject, was published by von Leonhard about twenty-two years ago, just at the time when the microscope was first efficiently applied to the study of rocks. Since then, Vogelsang and others have described the microscopical structure of some slags in connection with their study of obsidian and other allied volcanic rocks. At the date of the publication of von Leonhard's work, the questions in discussion differed materially from those which should now claim attention. There was still more or less dispute respecting the nature and origin of certain rocks which have now been proved to be truly volcanic by most unequivocal evidence. I am not at all surprised at this, since, as I shall show, there is such a very great difference in their characteristic structure and that of the artificial products of igneous fusion, that but for the small portions of glass inclosed in the constituent crystals, described by me many years ago under the name of "glass-cavities," there would be no positive proof of their igneous origin.

In studying erupted rocks of different characters we see at one extreme they are as truly igneous as any furnace-product, and at the other extremity hardly, if at all, distinguishable from certain deposits met with in mineral veins, which furnish abundant evidence

of the preponderating, if not exclusive, influence of water, and have very little or nothing in common with products certainly known to have been formed by the action of heat, and of heat alone. Between these extremes there is every connecting link, and in certain cases it is almost, if not quite, impossible to say whether the characteristic structure is due more to the action of heat than of water. The great question is whether the presence of a small quantity of water in the liquid or gaseous state is the true cause of very well-marked differences in structure, or whether greater pressure and the necessarily slow rate of cooling were not the more active causes, and the presence of water in one state or another was merely the result of the same cause.

The crystalline minerals in products known to have been formed by the action of heat alone have a certain very well-marked and characteristic structure, which is gradually modified as we pass through modern and more ancient volcanic to plutonic rocks, in such a manner as to show at once that they are intimately related, and yet differ in such characteristic particulars that I think other agencies than mere heat must have had great influence in producing the final results.

Mr. Sorby then gave an account of his experiments with crystalline blowpipe beads, with artificial slags, with rocks artificially melted, and with volcanic and granite natural rocks, and his conclusions were thus summed up:—"The objects I have described may be conveniently separated into three well-marked groups

viz., artificial slags, volcanic rocks, and granite rocks. My own specimens all show perfectly well-marked and characteristic structures, though they are connected, in some cases, by intermediate varieties. Possibly, such connecting links might be more pronounced in other specimens that have not come under my notice. In any case the facts seem abundantly sufficient to prove that there must be some active cause for such a common, if not general, difference in the structural character of these three different types. The supposition is so simple and attractive, that I feel very much tempted to suggest that this difference is due to the presence or absence of water as a gas or as a liquid.

"Considering how large an amount of steam is given off from erupted lavas, and that, as a rule, no fluid cavities occur in the constituent minerals, it appears to me very plausible to suppose that those structures which are specially characteristic of volcanic rocks are in great measure, if not entirely, due to the presence of associated or dissolved vapour. The fluid cavities prove that water was sometimes, if not always, present as a liquid during the consolidation of granitic rocks, and we can scarcely hesitate to conclude that it must have had a very considerable influence upon the rock during consolidation. Still, though these three extreme types appear to be thus characterised by the absence of water or by its presence in a state of vapour or liquid, I think we are scarcely in a position to say that this difference in the conditions is more than a plausible

explanation of the differences in their structures.

"Confining our attention to the more important crystalline constituents which are common to the different types, we may say that the chief structural characters of the crystals are as follows:—
 (a) Skeleton crystals; (b) Fan-shaped groups; (c) Glass cavities; (d) Simple crystals; (e) Fluid cavities. These different structural characters are found combined in different ways in the different natural and artificial products, and, for simplicity, I will refer to them by means of the affixed letters. The type of the artificial products of fusion may generally be expressed by $a+b$ or $b+c$; that is to say, it is characterised by skeleton crystals and fan-shaped groups, or by fan-shaped groups and glass-cavities. In like manner, the volcanic type may be expressed occasionally by $b+c$, but generally by $c+d$, and the granitic by $d+e$. These relations will appear more apparent if given in the form of a table as follows:—

Slag type	$\{$	$a+b$
		$b+c$
Volcanic type ..	$\{$	$b+c$
		$c+d$
Granitic type ..		$d+e$

Hence it will be seen that there is a gradual passage from one type to the other by the disappearance of one character and the appearance of another, certain characters in the meanwhile remaining common, so that there is no sudden break, but an overlapping of structural characteristics. It is, as I think, satisfactory to find that, when erupted rocks are examined from such a new and indepen-

dent point of view, the general conclusions to which I have been led are so completely in accord with those arrived at by other methods of study."

Geology at the British Association.—The Geological Section of the Association in 1880 was marked by the total absence of papers by local cultivators of science; a most unusual thing, and indicative of want of interest either in science or in the proceedings by the people of Swansea. Dr. Sorby, the president of this section, regretted that his ignorance of local geology prevented him from choosing that subject for his presidential address; but geologists will probably not regret this, seeing that the subject which he did choose — a comparison between the structure of artificial slags and volcanic rocks — had very important scientific bearings (*see p. 60*). He showed that a careful study of the formation of the former and of their structure throws much light on the origin and structure of the latter, and concluded that there is still much to be learnt respecting the exact conditions under which some of our commonest rocks are formed.

In this section Professor Prestwich challenged the completeness of the conclusion come to by Professor Ramsay (*see the President's address, section XII.*) as to the unvarying uniformity of the forces at work in geological action. In a paper on the submergence of the south-west of Europe he maintained that a superficial deposit known as "trail," "warp," or "head," was evidence of submergence in com-

paratively recent geological times; and while admitting that geological agents have been always the same in kind as they are now, he denied that they were always the same in degree.

The reports in this section are generally of much interest. That on the circulation of underground waters has important bearings on the water-supply question. In this year's report Mr. De Rance pointed out how large a quantity of water is being stored in the watershed separating the basin of the Thames and the Eastern counties, and in the Triassic sandstone in Lancashire, Cheshire, and the Midland counties, and that wells suitably sunk in these localities would tap an immense supply. The Committee on Erratic Blocks or Boulders make it their business to register the position and nature of all the great boulders which are scattered over the country, and a knowledge of which affords an important key to past geological action. The report of the Committee on the Exploration of Kent's Cavern seemed to show that they had pretty well completed their work; the discoveries which have been made in the cavern during the past 15 years have been invaluable in enabling us to draw conclusions as to the past conditions of our country. Another cave committee gave in its first report on certain caves in the south of Ireland which it has been deemed desirable to explore. This committee has only begun its work, but so far it promises well.

While many of the papers in this section were of only special

interest, there were a few which dealt with the larger aspects of geology. Mr. Whitaker's paper on the geological literature of Wales was appropriate and really valuable, and evidenced great research. Dr. G. M. Dawson's sketch of the geology of British Columbia was a distinct novelty, and was greatly the result of his own investigation as member of the Canadian Government Survey. Dr. Phené's paper on the geology of the Balearic Islands may also be regarded as a fresh addition to geological science; and perhaps still more so that of Mr. W. T. Blanford, an Indian geologist, on the geological age and relations of the Sewalik and Pikermi faunas. This last will be an important aid in enabling geologists so fill up the geological history of India. So likewise will be an interesting paper by Colonel Godwin-Austen on the Post-Tertiary and Glacial deposits of Cashmere. Interesting from the point of view of geological theory was Professor O'Reilly's paper, in which he tried to establish a relation between coast-line directions, as represented by great circles on the globe, and the localities marked by earthquakes in Europe. The truth of this theory it ought not to be difficult to test.

Mr. Charles Moore, in his paper in proof of the organic nature of *Eozoon Canadense*, kept alive a very old controversy, which has been recently revived with great keenness. This thing, which has been found in some of

the earliest rocks of Canada, has been maintained by Principal Dawson to be the remains of one of the earliest forms of organic structure on the globe. This opinion has quite recently been ably challenged by Dr. Möbius, of Kiel, whose paper on the subject has given rise to a lively controversy. Mr. Moore adduces what he believes to be fresh proofs of the organic nature of *Eozoon*, but it is very doubtful if his paper will finally settle the question. Professor Boyd Dawkins's paper on the action of carbonic acid on limestone is of some importance in enabling us to estimate the age of stalactitic deposits in those caves which yield ancient animal and human remains. Mr. Spurrell described his discovery of an ancient palæolithic manufactory at Crayford, in Kent, among brick-earth containing remains of a large number of extinct mammals. Mr. De Rance's paper on the pre-glacial contours and post-glacial denudation of the North-West of England was a valuable contribution to a knowledge of the long-continued and powerful glacial action which in past times must have scooped out the valleys, levelled the plains, and helped to mould the mountains of one of the most picturesque districts of our country. The other papers read, while as a whole they formed an important addition to geological knowledge and threw light on various geological theories, were of interest only to the geological specialist.—*Times*.

V.—METEOROLOGY.

Finding the Heights of Clouds.—Mr. Francis Galton read a paper before the British Association upon "Determining the Heights and Distances of Clouds." He said that this might be done by their reflection in a low pool of water and in a mercurial horizon. The calm surface of a sheet of water might be made to serve the purpose of a large mirror, in a gigantic vertical range-finder, whereby a sufficiently large parallax might be made for the effective measurement of clouds. The observation of the height and thickness of the different strata of clouds, and of the rates of movement, was at the present time perhaps the most promising, as it was the least explored branch of meteorology. As there were comparatively few places in England where the two conditions were found of a pool of water, well screened from wind, and of a station situated many feet in height above it, the author hoped, by the publication of this memoir, to induce some qualified persons, who had access to favourable stations, such as existed in Wales, to interest themselves in the subject, and to make observations. The necessary angles might be obtained with a sextant and mercurial horizon; but it would be convenient to have in addition a tripod stand, with a bar of wood across the top to support the mer-

curial trough, with some simple instrument for the rapid and rough measurement of altitudes.

Temperature and Rainfall of London.—Mr. A. Courtenay Fox submitted a paper to the British Association on some "laws" which regulate the succession of temperature and rainfall in the climate of London.

He stated the following definite propositions:—A cold spring is very prone to be followed by a cold summer, a cold summer tends to be followed by a cold autumn, and a cold autumn has a slight tendency to be succeeded by a winter of low temperature. Warm summers are generally followed by warm autumns. In no fewer than eight out of the twelve months (that is, in every one except February, March, May, and October) very low temperature tends to be prolonged into the succeeding month. If June, July, August, or December, be warm, the next month will probably be a warm one also; two months, June and July, tend when very dry to be followed by dry ones. On the other hand, a dry August indicates the probability of a wet September. A wet December is apt to be succeeded by a wet January. In addition to the foregoing there are also a few instances in which the rainfall of certain months appears to be definitely related to antecedent ex-

tremes of temperature and *vice versa*. Thus, if August or September be warm, the ensuing September or October inclines to be wet. If, on the other hand, September or November be cold, the succeeding October or December is likely to be a dry month. If February, June, or July be very dry, the next month has a strong tendency to be warm; if January, March or April be wet, we may also expect the next month to be a warm one, but a wet May or July gives a strong probability of cold weather in June or August respectively.

Temperature and Moisture of the Air near Large Lakes.—Any one who has been on the banks of one of the large Italian lakes, or in a boat on the water, on some quiet, clear autumnal evening, will have noted the remarkable fact that the air at the border of the lake, or over it, seems much moister than at a little distance from the lake over the open country. This is especially striking at times in the end of August or beginning of September, when somewhat fresh evenings follow days that are still very warm; one then observes shrubs and other plants getting coated with dew, but not in the immediate neighbourhood of the lake. Having often had his attention attracted by this phenomenon, Professor Cantoni last autumn made a number of exact measurements of temperature and moisture at different points in the neighbourhood of Lake Como, with a view to determining the exact condition of what was observed. The facts elicited afford quite an adequate explanation. The increase

of temperature of the ground (Professor Cantoni points out) is so considerable, compared with the small heating of the water and the air above it, that though the evaporation of the pure water increases more with the temperature than that of the moist ground, yet the latter, which is heated to nearly 50 degrees Centigrade must form much more aqueous vapour than the free water surface. On the other hand, the ground cools by radiation when the sun goes down much more quickly than the surface of the lake. These two circumstances bring the air over the lake and over the land very quickly under very different conditions of relative moisture. The air over the land, which during the day has been heated to a higher temperature, and cools much more quickly after sunset, must reach much more quickly its maximum of moisture than the air over the water.

An Extraordinary Shower.—The Naples journals report a remarkable phenomenon observed at Catania on the night of the 29th-30th of March, 1880. A violent agitation of the atmosphere had been predicted to take place about that time, and in fact the barometer fell rapidly during the night. For some hours Catania was visited by a meteoric shower accompanied by rain. The fine dust which fell had the same character as that which has fallen on other similar occasions, that is, in colour it was red, was of the same chemical composition, and contained small mineral particles and minute infusoria. It presented on this occasion, however, objects of a special interest, as it

contained a remarkable quantity of iron, either in its metallic shape or in metallic particles surrounded by a stratum of oxide. The fragments are of various size and of an irregular or spherical form, as if they had been fused. All are attracted rapidly by the magnet.

Wind and Weather.—In the spring of 1880, Mr. R. H. Scott delivered three lectures at the Royal Institution on "Wind and Weather." He referred to barometric pressure as having of all atmospheric phenomena the most immediate connection with air motion. Barometric readings needed various corrections. If they left out instrumental corrections, the two most important were those for temperature and for altitude above sea-level. The correction for temperature was easily understood and easily made. It was needed because the mercurial column was longer when it was warm than when it was cold, while the weight remained unaffected by the change. The readings were reduced to a constant temperature, 32 deg. Fahrenheit being taken as the standard. The correction for sea-level was a much more difficult subject to understand. Corrections made for the Baltic, the Bay of Bengal, and the China seas would be found to differ much.

The next subject referred to was diurnal and annual range, and it was shown, *inter alia*, how the daily range was related to the daily curve of temperature. As to the annual range, a curve for 100 years for London, drawn from figures recently calculated by Mr. W. S. Eaton, was shown

to differ materially from a curve for 20 years from Greenwich, and this proved how difficult it was to obtain trustworthy results in meteorology from short periods of observation. The prevailing winds were then described. The winds of the temperate zone were explained, with their relation to the distribution of temperature, and it was shown how in these islands the idea of any exclusive predominance of south-west and north-east winds over the others was unfounded.

In a subsequent lecture Mr. Scott dealt with moisture, under the heads of evaporation, the measurement of moisture, and the precipitation in the form of dew, mists, rain, &c. Evaporation, he said, was a very important subject, as it had such intimate bearings on water supply. For example, at Nagpore, Mr. Binney found that he had to arrange tanks of twice the dimensions required for the supply to allow for evaporation. On a smaller scale the principle applied to England. At present we had no suitable instruments devised for a trustworthy measurement of evaporation. They often indicated results greater than the moisture received.

Another great difficulty in estimating the evaporation from a large area was that so many different kinds of surfaces were presented. For example, in Hyde Park there was an evaporation from the Serpentine; that from the trees was less, from the grass less still, and from the road least of all. Messrs. Lawes and Gilbert had experimentally shown that in dry weather corn would dry up the ground to many inches below

the surface, while a well-mown lawn would do so to a much less distance. There was great need for further attention to this subject. The determination of the amount of moisture present in the atmosphere was the next consideration spoken of, and the instruments employed in these observations were described. It was often calculated by the pressure on the barometer, but also by the wet-bulb thermometer, the great objection against which was that it was utterly useless in time of frost. As regards our own sensations, it was the amount of moisture in the air which made a high temperature disagreeable to us or not. For example, in a ship lying off Hong Kong some people in the gun-room agreed as to feeling a day oppressively hot, one of the hottest they had experienced. A reference to the thermometer showed that the temperature was but 85 deg. F., but the air was laden with moisture. Our sensations of heat were no sure guide as to real temperature.

As to vapour, its distribution was probably very local. The mean curves showing amount of vapour followed very nearly the mean curves of temperature. The variation of distribution in vertical height was, however, much more complicated. On the Andes the amount of vapour in the air was only one-tenth of that nearer the sea. The movements of air conveying moisture had much to do in moderating extremes of climate. Great heat was removed from one region taking up moisture, and when the moisture was deposited in another region the heat was liberated.

As to rain, Mr. Scott referred to Lord Rayleigh's experiments showing that the formation of raindrops seemed to depend much on their electrical condition. After an allusion to all rain arising from a chilling of the atmosphere containing the moisture, the records of rainfall of 2,000 British stations were spoken of, and in conclusion Mr. Scott pointed out that after all our increased knowledge we were still powerless to protect ourselves against rain, or to know how to deal with an unusual downpour. The felling of timber and draining had had much influence. Many of the upper parts of rivers were unnavigable from the water running away so rapidly, and with this came also the flooding of the lower parts. The management of the results of heavy rainfalls was one of the great problems we had to consider.

Weather and Plant and Animal Life.—Miss Eleanor A. Ormerod, the first lady Fellow of the Meteorological Society, and an active worker in the extensive field of meteorological observation, has just completed a work which has involved the labour of years, not only of herself, but of several assistants. This work has been to tabulate the results of the observations made by Miss Caroline Molesworth, at Cobham, during the quarter of a century that elapsed between 1825 and 1850. This lady devoted a lifetime to a study of natural phenomena, and at her death in 1872 she left an enormous number of manuscripts relating to observations on plant life in relation to the weather, which extended

over a period of more than 40 years. These, or the majority of them, came into the possession of the Meteorological Society, in whose library they were known as the "Cobham Journals." About four years ago Miss Ormerod, at the request of the Council of the Society, undertook the task of editing a volume showing in an abstract and tabulated form the results of Miss Molesworth's observations.

In a volume of 180 quarto pages the results of Miss Ormerod's labours have been given to the Society; and as showing the work that has been accomplished we may mention that over 75,000 distinct observations have been consulted, tabulated, and analysed, and their results described. The lessons learnt from these observations point to the fact that the meteorological conditions of the last quarter of the year appear to have great influence on the dates of vegetation in the ensuing spring, this influence being often modified according to the depth to which succeeding cold may penetrate the ground, and, consequently, affect the root action, these effects being shown by the comparison of dates of deep and shallow-rooted plants. It is also shown that the "amplitude"—*i.e.*, the difference in date between the earliest and latest observations of first flowering—is greatest in the bulbous and fibrous surface-rooted plants, and least in the bushes which descend to a depth at which they are rarely exposed to any severe cold, and not at all to any sudden changes of temperature (as may be easily tested by the earth thermometer), this

effect not being merely from their less succulent growth, as the elm (which, as is well known, is most troublesome at times from its surface roots) has a large amplitude—viz., 57 days.

As regards earliness of flowering, or the other phenomena of plant life in the spring, these conditions appear to differ from the average date very much in accordance with the duration of the previous season of warmth. That is, the early spring flowering, commonly following on a mild winter, usually differs in amount of variation from the average date according to the length of the preceding period of warmth, and the records appear to show that, though a temporary check from cold winds or other causes may occur, there is a subsequent return of the old plant dates to earliness, this being mainly attributable to the earth temperatures at some slight distance beneath the surface not being affected by the temporary chill, and subsequently regaining their influence on the root action. Ripening of the wood in a warm autumn may have its special effects, but in the present observations spring earliness seems mainly dependent on mild temperatures and the amount of moisture during the latest months of the year when ripening would be completed.

Looking at some of these points in detail with regard to 1828, 1833, 1834, 1835, 1837, and 1840—years in which the dates of spring vegetation were more or less before the average—we find that in each case a long period of warmth and moisture preceded a flowering continuously from ten

to 40 days before the average. A mild and dry winter period was followed by flowering slightly later than the above, but still early in commencement, and continuing for the most part early. A mild and damp winter, succeeded by cold in January, is noticeable as having the commencement of flowering retarded, but the dates afterwards become for a short time early till subsequently retarded by a return of severe weather. There are also three years in which early dates follow on a generally mild and wet winter period, in two cases checked afterwards by cold in March or April. In the springs of 1826, 1827, 1829, 1830, and 1838, the dates of flowering were more or less after average time, and these years are taken as showing the effect of cold in retarding vegetation, not only when long continued, but also when occurring for a short time after such periods of warmth as have not thoroughly affected the ground.

The other years were generally too varied to admit of their conditions being generalised, but they nevertheless appear to agree in pointing to the important part played by the earth temperatures and conditions on the exposed part of the plant. In short, all the observations point to the advantages of a well-drained and warm soil over one that is wet and cold, and that from any cause. With regard to the amplitudes of flowering, these are shown to be much shorter with deep-rooted trees and shrubs than with other kinds. Taking such as are native, or in natural circumstances, it appears that the amplitudes vary from about

20 to 38 days. Bulbous or succulent rooted plants run to considerable lengths, from 36 to 86 days.

Miss Molesworth, in addition to her observations on plant life, made also a large number of notes relating to the appearances of the spring birds of passage. These show an amplitude in the case of the cuckoo, nightingale, swallow, and house martin of respectively 11, 22, 29, and 34 days, and also a wonderful coincidence in the dates of the appearance of the first two. Taking the observations on birds generally, however, the dates of appearance vary so irregularly that no conclusion can be drawn as to a correspondence existing with meteorological conditions in this country. The only indication of this was in 1838, when in a cold spring following on a cold autumn the cuckoo, nightingale, and swallow were observed much after the average date. The appearance of rare birds (of species noted in ornithological manuals as occurring occasionally in the estuary of the Thames) is noticed from time to time, but these are only incidentally mentioned, and might probably be driven in under stress of weather.

With regard to insect life, Miss Ormerod regrets that so little information is given, "as the meteorological circumstances attending their appearance in the vast swarms in which they from time to time spread devastation through the kind of crop they attack are much needed for the economic considerations in connection with agriculture." However, some of the notes are of interest. One is on the appearance of aphides in

great numbers coincidentally with the larvæ of the ladybird beetles, which prey on them. Another note relates that heavy rains washed away the turnip "fly," while we are told shortly afterwards of the appearance of the turnip sawfly on the same spot in the imago state. This observation is of great interest, as it shows that rain does not, as is generally supposed, interfere with the development from the pupal state of this, one of the most destructive of our farm insects. For the purpose of comparison the readings of the instruments at the Royal Horticultural Society's gardens at Chiswick are given for each month in the years referred to.—*Times*.

International Meteorology.—The International Meteorological Committee appointed by the Congress of Rome (1879) held its first meeting at Berne on the 9th September. The following was the programme of questions considered by the committee:—1. Report on the action of the committee since the date of the Congress at Rome. 2. Report of the Polar Conference (Weyprech's project) held at Hamburg in October, 1879. 3. Proposed conference for agricultural meteorology, summoned for September 6, at Vienna. 4. Proposed comparison of the standard instruments of the chief observatories of Europe. 5. Proposed catalogue of meteorological observations and of meteorological works and memoirs in all languages. 6. Proposed international tables for the reduction of observations. 7. Proposal for an inter-

national meteorological dictionary. 8. Report on the meteorological organization of England in 1877, being a supplement to the fifth appendix to the report of the Roman Congress. 9. Proposal by Captain Hoffmeyer for an international telegraphic service for the North Atlantic. 10. Proposal respecting the exchange of meteorological publications by post. A private conference on the relations of meteorology to agriculture and forestry was held at Vienna on September 6. The following was the programme of subjects for discussion:—1. What are the mutual relations of the meteorological elements on vegetation; not only those which are proved to exist, but those which are theoretically supposed to be probable? 2. What observations of meteorological elements are to be particularly attended to, with special reference to their influence on vegetation? 3. How far, and in what way, can meteorological observatories and stations, without interfering with their other work, include these observations in their sphere of operation? 4. Would it not be useful, with a view of establishing special systems of observations for this object, as, for instance, phenological observations, to prepare general instructions? 5. Can at the present moment meteorological central offices issue weather forecasts for the use of agriculture with reasonable prospects of utility, and if this question be answered in the affirmative, how can the service be organised as fully as possible?

VI.—HEAT, LIGHT AND SOUND.

Professor Donders on Colour.

—The most distinguished oculist in Holland delivered, early in 1880, a popular lecture on colour in the rooms of the Felix Meritis Society at Amsterdam. After an experimental analysis of various popular notions on the subject of his lecture, Professor Donders proceeded to demonstrate that green must be ranked with the primitive colours, like red, blue, and yellow. Green, the professor argued, could not be produced by mixing pure yellow and blue: such a composition would be white. The green colour apparently derived from the mixture of two paints was, in reality, the result of "subtraction."

The Effect of the Telephone on Uncivilised Beings. — The effect of the telephone on uncivilised beings may be turned sometimes to good account, to judge from a story in the *San Francisco News Letter*. Some horses had been stolen in an out-of-the-way part of California, and suspicion fell upon a certain Indian. A telephone had been recently introduced into the neighbourhood, and it occurred to the owner of the stolen horses to get the Indian to come in and hear the "Great Spirit" talk. The Indian took one of the cups, and was thrilled with astonishment at being apparently within hearing of the Great Keeper of the happy hunting-grounds, while he was horror-

struck when, after a little preliminary speech, he was solemnly commanded by the Great Spirit to "Give up those stolen horses." Dropping the cup as if he had been shot, he immediately confessed the theft, and tremblingly promised that, if his life were spared, he would restore the horses at once.

Utilisation of the Sun's Rays.

—Very practical results appear to have arisen from the experiments of M. Mouchot in utilising solar heat. By means of a large collecting mirror, 12ft. 6in. in diameter and capable of resisting the strongest gale, he has succeeded in raising over 60 pints of water to the boiling-point in 80 minutes, and in 1½ hour more produced a steam pressure of eight atmospheres. During one day, in March, 1880, in Algiers, a horizontal engine was driven at the rate of 120 turns per minute, under a pressure of 3½ atmospheres; and at another trial the apparatus worked a pump, raising at the rate of 264 gallons of water per hour one yard high. The pump was kept going from 8 a.m. to 4 p.m., and neither strong winds nor passing clouds sensibly interfered with its action. M. Mouchot can now readily produce a temperature applicable to the fusion and calcination of alum, the preparation of benzoic acid, the purification of linseed oil, the concentration of syrup, the distil-

lation of sulphuric acid, and the carbonisation of wood.

Novel Effects of Light passing through a Slit.—Lieut. Commander Michelson has lately called attention in the New York Academy of Sciences to some curious effects of sunlight when seen through a narrow slit. As the width of the slit is diminished the diffraction bands spread out and separate, until nothing is seen but the central bright space. At this stage (the width of the slit being 1-100th to 2-100ths of a millimetre) the light is found to have become slightly bluish, and a Nicol prism reveals in its traces of polarization. On further narrowing the slit the blue tint and the polarization become more decided; and when a width of about 0-001 millimetre has been reached, the tint changes to violet and the polarization appears to be complete. This polarization is in a plane at right angles to the slit. The material of the edges of the slit does not seem to essentially affect the result. Slits made of iron, brass, and obsidian were used; the last proved best, but probably because the edges were more perfect. The results can be shown in a very striking manner by using a double-image prism, when the two images may be compared side by side. A suggested explanation of the polarization is that most of the light reaching the eye has been reflected from the edges of the slit; and the position of the plane of polarization would seem to support this. But it is objected that, if it were so, there should be a difference in the behaviour of different materials, and that the

polarization should be observed when the slit is wide as well as when it is narrow. The experiments in any case seem to prove (1) that a very narrow slit polarizes light, as described, and (2) that it lets the shorter waves of light pass more freely than the longer ones.

The Telephone in the Nursery.—The telephone in the nursery is proving a real boon to anxious mothers in America; so *Iron* tells us. Thus recently a loving grandmamma, just promoted to the honours of that relationship, was awakened in the dead of the night by her daughter's alarmed voice *per* telephone, "I'm sure baby has the croup; what shall I do?" Grandmamma promised to be with her daughter in a moment, and communicated with the family doctor. He in his turn requested to be put in connection with the anxious mamma, and bade her lift her child to the telephone, and let him hear it cough. The child coughed, and the doctor at once declared the ailment to be of no consequence, so the disturbed family settled once more peaceably to rest.

The Colour of the Sky.--"Why is the sky blue?" is a question which has often been asked, but never satisfactorily answered. Helmholtz offered an explanation which depended on the reflection of solar light by the air particles in the atmosphere. These particles, being very minute, would reflect preferably the shortest waves of light, *i.e.*, blue waves, while they would allow the longer waves, corresponding to green and red light, to pass through them; just as a log of wood floating on the surface of still water would

throw off the tiny wavelets caused by a falling drop in its neighbourhood, while the same log in long ocean swells would be tossed to and fro without noticeably impeding the progress of the waves.

Dr. E. L. Nichols (*Philosophical Magazine*, Dec., 1879) has propounded another view, which has much to recommend it. According to Young and Helmholtz's theory of colour-impression, there are in the eye three sets of nerve-termini, one set chiefly influenced by the red, another by the green, the third by the violet rays. The impression of colour is the resultant of the intensities of these three effects. The impression upon these nerves is not directly proportional to the intensity of the ray, the different nerve-termini being subject to different laws. For very feeble rays the "violet" nerves are very sensitive, while the "green" and "red" nerves scarcely act at all. As the light increases in intensity, the "red" and "green" nerves increase in activity, while the "violet" nerves become tired and dazzled. For rays of dazzling brilliancy, the "red" nerves are in their most sensitive condition. Thus, of the simple colours, as the brightness increases, red and green change to yellow, blue becomes white.

Daylight, at ordinary intensities, affects the three sets of nerve-termini equally; the resultant impression is whiteness. Now, daylight is simply the light of the sun weakened by manifold diffuse reflections. The direct rays of the sun, as we let them fall upon any colourless object, appear also a white light; but on attempting at noon on a clear day

to gaze into the sun's face, the impression is of blinding yellow. It is not that the direct rays differ in composition from diffuse daylight, but that the "violet" nerves cannot transmit the action of such strong light. The moon, with enormously less illuminating power than the sun, seems bright, and is far brighter than the open sky. In passing from the intensity of the moon's rays to those reaching us from a corresponding bit of open sky, we may, perhaps, take a step as great as that between the brightness of sun and moon. In general, white light will appear bluer and bluer as its intensity diminishes, and this law will apply to the skies; as the light they reflect becomes fainter and fainter, they will increase in blueness, even though the light by the process of reflection suffer no change in composition.—*Academy*.

Ascertaining and Recording the Velocity of Light.—Professor Simon Newcomb, astronomer, and superintendent of the *Nautical Almanack*, U.S., has finished his new apparatus for ascertaining the velocity of light, and is making a series of preliminary experiments to test its parts. He was delayed several weeks in the work of construction by the difficulty experienced in getting a small cog-wheel of material possessing both strength and elasticity sufficient to receive a power giving two and even three hundred revolutions a second. Brass, steel, and other metals were tried in vain, and success was only reached when, upon the suggestion of Alvan Clark, of Cambridge, Mass., raw hide was adopted. The wheel is about an inch and a half in diameter, and a

little thicker than a silver dollar. Professor Newcomb has selected for his base of operations a point at Fort Whipple, on the Virginia side of the Potomac, opposite Washington, where his apparatus has been set up in buildings erected for the purpose.

Recently a correspondent of the *New York Tribune* had an opportunity to see the apparatus in operation, and of hearing from the lips of Professor Newcomb an explanation of the principles upon which its results are to be worked out. Its most conspicuous parts are two brass tubes, eight feet in length by about two inches in diameter, placed horizontally at right angles to each other, like the two branches of the letter L, and resting at the angle and at the outer ends upon low solid columns of brick and stone. These tubes are telescopes, differing from ordinary instruments only in respect to their great length and small diameter. One of them is immovably fixed upon its bed of masonry, while the other—being laid in a plane about two inches lower, with its "object" end upon a pivot—swings by means of a delicate screw to the right or left through a radius of one or two degrees. At the angle formed by the line of the two telescopes, and placed so as to be in the line of vision of both, stands a small mirror of peculiar construction. It is a square column of steel, five inches in length by two in diameter, and plated upon its four sides with nickel. It is mounted top and bottom upon pivots, so as to revolve horizontally, and it is to this mirror that the raw-hide cog-wheel conveys its power. Affixed to one

of the wheels which give motion to the mirror is a device for breaking an electric current, connected with a recording clock, so that the number of revolutions of the mirror each second is automatically recorded. The power to give the mirror its revolutions is furnished by a steam-engine built for the purpose, and placed in an adjoining building.

A few feet distant from the eyeglass of the fixed telescope, and in a direct line with the instrument, is placed a helioscope—an apparatus consisting of a mirror mounted upon complicated bearings and moved by clockwork, so that when wound up and adjusted it will follow the apparent motion of the sun, reflecting its rays for any desired length of time upon a given point. The rays, or to speak scientifically, the waves, of sunlight thrown from this instrument are brought to a focus by an intermediate lens upon the eyeglass of the fixed telescope, through which they pass to the surface of the revolving mirror at the other end.

At the Naval Observatory in Washington, some 8,000ft. distant from Fort Whipple, across the Potomac (its exact distance will be ascertained by the Coast Survey before actual work is commenced), is placed a fixed mirror, circular in form, 3ft. in diameter, and of such a delicate degree of concavity that light thrown upon it—as from the revolving mirror at the fort—is returned again and brought to a focus as near may be upon its starting point. In other words, this mirror is a section of a shell, which, if complete, would be three miles or more in dia-

meter. Of course, to all appearance, it is perfectly flat.

Now, to understand the working of the apparatus, let it first be supposed that the revolving mirror is at rest. The course of the sun's rays will be as follows:—Striking the mirror of the helioscope, they will be reflected through the intermediate lens upon the eyeglass of the fixed telescope, through the instrument to one side of the revolving mirror, thence to the concave mirror across the Potomac, by which they are returned to the revolving mirror, and are finally reflected through the movable telescope to the eye of the observer placed at the eyeglass. The point at which this telescope rests to receive the sun's rays after they have made their tortuous journey, the revolving mirror being at rest, is marked zero.

Now apply the steam and set the revolving mirror in motion. It sounds like the concentrated shriek of a hundred terrified children. Give it 200 revolutions a second, and its four sides will throw 800 reflections of the sun's rays across the Potomac to the mirror at the Observatory. Nothing but the shriek indicates that the mirror is in motion; it looks like a small polished cylinder. The observer no longer catches the sun's reflected rays through the movable telescope at zero, but swings his instrument to the right or left, according to the direction in which the mirror is made to revolve, until they again reach his eye. Reflections, following each other with such enormous rapidity, appear as a single reflection. This, then, is the whole process. It re-

mains only to note the number of revolutions per second, as indicated by the recording clock, and the degree of deflection from its normal position at zero given to the movable telescope, and work out the result as a sum in arithmetic. It will be seen that, while a ray of sunlight is making its journey across the Potomac and back, between the revolving mirror and the fixed concave mirror, the former will have made some portion of one of its revolutions. This portion is represented by the degree of deflection which it is necessary to give to the movable telescope to catch the rays upon their return and second reflection from the revolving mirror.

The following propositions, pencilled by Professor Newcomb, illustrate more accurately the results to be attained from given hypotheses:—Speed of mirror, 200 turns per second; deviation of reflecting ray, $2\frac{1}{4}^\circ$; distance, 1'6 mile. Results:—Motion of mirror in 1 second, $360^\circ \times 200 = 72,000^\circ$; observed motion of mirr. r while light is going and coming, $1\frac{1}{4}^\circ$, is 72,000 divided by $1\frac{1}{4} = 57,600$. Then velocity of light = $2 \times 1'6 \times 57,600 = 184,320$ miles per second.

Professor Bell's Photophone.—From time to time announcements have been made that the wonders of the telephone have been eclipsed by what, since the word "telescope" is appropriated to a better known but not really less wonderful instrument, I may call a "telegraphoscope," an appliance for seeing by telegraph. It is stated that Mr. Graham Bell was at work at the problem, and, if I am not mistaken, this distinguished

inventor himself announced its solution a little while ago. However, Mr. Bell's work had either throughout another intention, or, as often happens in physical investigations, it branched off in a different direction and produced results perhaps originally unexpected. A full account of his latest research is given in a paper read by Mr. Bell himself at a meeting of the American Association for the Advancement of Science. According to this paper, which is full of scientific interest, Mr. Bell has performed a very marvellous feat indeed. He has succeeded in telegraphing, or rather "telephoning," along a beam of light. The beam of light took the place of the ordinary connecting wire, and by its means sounds produced at one end of the beam were reproduced at the other. The invention (for such it is rather than a discovery) may or may not have any immediate practical application, but of the scientific interest attaching to it there can be no question. As with the telephone, simple means and well-known properties are made to produce startling results. Startling, however, as they are, they will certainly meet with ready acceptance. There is nothing in Mr. Bell's paper which does not fit in with previously known facts, and its author's reputation alone suffices to prevent any hesitation in receiving his conclusions.

The curious properties of the rare metal selenium are well known to electricians, and have frequently been made the subject of experiment. The property, which is believed to be peculiar

to itself, is that of offering more or less opposition to the passage of electricity, according as it is acted upon or not by light. It is therefore easy to conceive that if a piece of selenium were introduced into an electric circuit in which was also a telephone, alternations of light and darkness might be caused to vary the strength of the current, and such variations would produce sound in the telephone. This may be made clearer by considering the analogy of the microphone, for the selenium would act, in fact, as a microphone sensitive to light. In the microphone mechanical vibrations vary the conductivity of the materials of which the instrument is constructed. In the case of selenium the luminous vibrations affect the conductivity of the metal. In either case these variations of the current would affect the whole length of the current, and would be manifested by a sound in the telephone.

This idea was put forward by Mr. Bell himself in a lecture in England two years ago, when he stated that he believed it would be possible in this manner to "hear a shadow" fall on a plate of selenium. But it was found that attempts to realise the idea failed, because the selenium was so bad a conductor; its "resistance" was so great that it could not be used with so sensitive an instrument as the telephone. Mr. Willoughby Smith, a well-known English electrician, stated at a meeting of the Society of Telegraph Engineers that he had succeeded in hearing the fall of a ray of light on selenium; but this experience does not seem to have

been repeated. The solution of the problem appears to have been due to the discovery by Mr. Bell of a method of treating selenium by which its conductivity was increased. Selenium, like the more common element sulphur, exists in several states. In one of these states, the "vitreous," produced by melting and rapid cooling, it is a non-conductor. In its "crystalline" or "metallic" form, produced by melting and slow cooling, it conducts electricity, though feebly, and it is in this state that it has been experimented with. By a method of heating to a certain point and then cooling, and by certain improvements in the method of attaching the connecting wires, Mr. Bell succeeded in constructing "cells"—small plates fitted with conducting wires suitably arranged—of selenium, the resistance of which might be denoted as 3, while the best previously made was as 2,500 (300 ohms and 250,000 ohms) in the dark. On exposing the cell to light the resistance was diminished to about a half (155 ohms). By this means the fall of light—the blow struck by a ray—was rendered distinctly audible.

So far, Mr. Bell had only improved on what had been accomplished by other inquirers. His next step was more original, and one which, perhaps, would not have suggested itself to any mind not already intent on the problem of conveying sound from place to place. The idea once suggested, it is not difficult to conceive that if the intensity of the light falling on the selenium were caused to vary in correspondence with the vibrations, say, of the human voice,

such vibrations would be faithfully reproduced in the telephone, and the voice would be heard. Further, the apparatus for thus regulating the impact of light might be removed to some distance from the selenium without affecting the result, so long as the beam of light shone with sufficient strength upon the sensitive cell. We should then have sound conveyed by light, or at least light affected by sound at one point in such a way as to be capable of reproducing sound at any other point to which it might be reflected.

The apparatus used by Mr. Bell is of a sufficiently simple character. A plane mirror of flexible material, such as silvered mica or microscope glass, is employed to reflect the light—sunlight or a strong artificial light, concentrated upon it by a lens. The speaker's voice is directed against the back of this mirror, which is thrown into vibrations in the same way as the diaphragm of a telephone, and communicates these vibrations to the beam of light. The light reflected from the mirror is, after passing through a second lens, received at the distant station by a parabolic reflector, in the focus of which is placed a selenium cell in circuit with a local battery and telephone.

With instruments arranged as above described, Mr. Bell states that a number of trials have been made, over distances too great to permit of sounds being heard directly through the air. The greatest distance mentioned is 213 mètres, or about 230 yards. Mr. Bell believes that similar results may be obtained at whatever distance a beam of light can be

flashed from one observatory to another. This belief requires experimental verification, and until it is so verified, it will be wise to reserve the expression of opinion as to its possibility. Should the inventor's hope be realised, his apparatus will have important practical applications. In circumstances such as those in which the heliostat recently proved itself so useful, the "phonoscope" would be still more valuable.

For experimental purposes a different apparatus was used. By means of a perforated disc rotating before a fixed perforated screen, a beam of light was rapidly interrupted. These rapid alternations of light and darkness falling on the selenium produced a musical note in the telephone, the rotating disc itself being absolutely silent. Light is thus made to produce sound, and the ancient fable of Memnon's statue is realised by modern science. Aided by his rotating disc, Mr. Bell has found that many other materials besides selenium are affected by light, faint sounds being audible from the bodies themselves, without the intervention of a telephone and electric battery, when the interrupted beam is incident upon them. Probably these results will need further experiment before they can be finally accepted. For instance, Mr. Bell does not state what precautions he took to prove that the effect was not due to heat, or under what conditions and how often the test was made.

The instructions given in the paper seem to be sufficient to enable anybody to try Mr. Bell's experiments for himself, and doubtless many will soon do so.

Without, however, waiting for the results of such experiments, I think we may congratulate him on having at once made an addition to our scientific knowledge and discovered another possible application of science to practical purposes.—*Times*.

Colour and Shadow.—Mr. W. Spottiswoode, President of the Royal Society, delivered a lecture on colour and shadow in March, 1880, in the Library of the Memorial Hall, Farringdon Street. The lecturer in the course of some introductory remarks, after speaking of the variety of aspects in which the phenomena of nature necessarily presented themselves to differently trained and differently instructed minds, referred to the fact that many theories had at different times been put forward as explanations of colour. Sir Isaac Newton undoubtedly laid the foundation of the theory of colour, and from his explanation of his experiments there was now no appeal; yet it did happen that from a distant country and from a mind differently constituted there arose an opposition which, although interesting as a phenomenon, offered no permanent refutation of Newton's views.

He referred to the poet-philosopher Goethe, whose theory of colour had arrested attention partly from the acumen with which he pursued scientific experiments and partly from the charm with which he invested every subject that he touched. He certainly did present the theory of colour in some remarkable aspects, and performed experiments which ultimately proved of exceeding importance. It would be re-

membered that Goethe attributed colour to the transmission of light through turbid media. The phenomena to which he drew attention were undoubtedly real phenomena; but he did not see wherein the truth of them lay. It was true that colour was due to that kind of dimming or shadowing of light which Goethe had in view, but he did not perceive where the general shadow and what might be called the selective shadow began and ended. The true interpretation of his experiments was not grasped until our own day, when the subject was investigated by Dr. Tyndall.

The lecturer then, without pursuing any further the consideration of Goethe's theory, proceeded to illustrate, by a beautiful series of experiments with the polarized rays of an oxy-hydrogen lime-light, the changes of colour which could be obtained by passing light through crystals, and shadowing out or obliterating with selective shadows different parts of the prismatic spectrum. The experiments of Mr. Spottiswoode showed that colours differ in three ways—that is to say, in tint, in illumination or brilliancy, and in saturation or depth of colour, variations depending upon shadow, either general or selective, the selective shadowing being the suppression of one or more of the ingredients of which whitelight is compounded. The lecturer concluded with some experiments showing how the application of these observations to the appearances of crystals placed in this instrument at once displayed differences in their physical characteristics.

In the short time at his disposal, Mr. Spottiswoode said he had been able to touch upon but one aspect of his subject, upon one particular instance out of an infinite series or chain of phenomena which surrounded us in every part of the universe. The colours of the grasses of the field, of the flowers, and of the fruits of the garden, the tints of the sky, or the beautiful colours playing around the setting sun were all due to selective shadows, although differing in the special disposition from those exhibited on the screen that evening, and it was to the selection or combination of them that these varied charms of nature were due.

The Topophone.—A new instrument, called by this name, has been experimented upon and described by Professor Morton in his report to the Lighthouse Board of the United States, by which the exact direction of sound given by fog-horns or fog-bells may be ascertained. The machinery is very simple, and consists of a vertical rod passing through the roof of the deck cabin, to the upper end of which are attached two adjustable resonators. Below these is a pointer, set at right angles to the bar, while rubber tubes pass through the cabin roof and are connected with a pair of ear tubes. The whole apparatus can be turned towards any direction, and the result is that any person sitting in the cabin, by turning round until the least sound was perceptible, would bring the pointer to within ten degrees, or less than one point, of the direction.

VII.—ELECTRICITY AND MAGNETISM.

Lighting up a Fish.—M. Trouvé has been exhibiting his electrical polyscope at the annual meeting of the Physical Society of Paris. It was placed in the stomach of a fish, who suffered no uneasiness, and the electric light rendered its body semi-transparent.

Lightning Conductors.—Mr. Preece brought before the British Association his investigations into the proper form of lightning conductors, and proved by various experiments that their efficacy depended upon their sectional area and not on their surface. Ribands and tubes were expensive and unnecessary. No better conductor could be devised than a solid rod or wire rope.

Magnetic Disturbances.—Professor Adams read a paper before the British Association on the comparison of declination magnetographs at various places. The object of the paper was to show that many of the sudden magnetic disturbances occur over very great areas, but sometimes in opposite directions.

Superior Magnets.—M. Carré, in the *Revue Industrielle*, publishes a description of his method of making superior magnets in cast iron. He melts cast iron, very slightly carburetted, in earthen crucibles. He adds to it 1·5 per cent. nickel, 2·0 per cent. tin, and 0·5 per cent. of copper. The result is stated to be remarkable.

A Use of Gold in Electricity.—M. Berthelot states in *Comptes Rendus* and *Annales de Chimie* that gold employed as a positive pole in sulphuric acid is rapidly oxidized and dissolved. This takes place only under the influence of the galvanic current.

The best form of Magnet for Magneto Machines.—Mr. Ladd read a paper before the British Association in which he said: "At the British Association meeting at Dundee in 1867, I made some remarks upon different forms of magnets, and exhibited many diagrams, showing, by the 'lines of force' naturally arranged, the great superiority of the circular magnet where an armature is to be employed. Since that time some thousands of that form of magnet have been made for medical, mining, and other purposes. Some months ago, in conversation with M. Breguet, of Paris, I showed him these same diagrams, and he was very much impressed with their importance; he has since then constructed a machine using the Gramme armature; and with a smaller quantity of steel in the magnets he has made a far more powerful machine than hitherto constructed with either the Jamin or the ordinary horse-shoe form. It is also more symmetrical in appearance, and occupies less space. With this machine I can heat to incandescence 19 inches of platinum wire by four turns of

the handle, while to heat 14 inches of the same size wire by a machine having a Jamin magnet it took ten turns of the handle."

The Future of Electricity.—Dr. Werner Siemens, of Berlin, in a lecture on "Electricity in the Service of Life," dwelling on the electric transmission of force, prophesied that "the energy of the solar rays, manifested in currents of air or in falls of water, may by-and-by, through the electric current, furnish all necessary heat, and render us independent of ordinary fuel."

Dynamo-Electric Machines.—A lecture was delivered in March 1880, by Dr. Siemens on the various applications of the dynamo-electric machine. He commenced with a reference to Faraday's great discovery of the magneto-electric or induced current. From *a priori* reasoning Faraday had several years previously concluded that such currents must exist, but with the apparatus then at command he could not detect them. The utilization of the induced current was a work of much time and thought on the part of those who followed Faraday. The first machine on the dynamo-electric principle invented by the lecturer was explained by him to the Royal Society in 1867. This machine differed from magneto-electric arrangements in the substitution of electro magnets for permanent or steel magnets. The electro magnets were excited by the current produced by the armature of the machine itself. Rotation might be produced by steam, hand or water power, and the power was available by wire at a distance of 20 or 30 miles.

Atmospheric Electricity in the Sahara.—In some tropical countries the electrical phenomena of the lowest atmospheric layer are much more marked than in temperate climates. Some interesting facts in this connection have been lately given by M. Amat from experiences in the northern Sahara. Without insulating himself from the ground, he could often get long sparks (0·05 in. to 0·07 in.) by simply passing a pocket comb through his hair or beard. This succeeded best in dry, hot weather, on return from a long excursion over arid plains, the most favourable time being in the evening from 7 to 9 o'clock. Some lower animals, and especially horses, present electric phenomena still more strikingly. On hot summer days, one sees on Arab horses long hairs diverging from the middle of the tail. Caressing the tail with the hand, a number of crackling sounds are heard, and if it be in darkness, sparks are seen. The electricity liberated by the tail of horses M. Amat finds to be positive. Man, in direct communication with the ground, does not show such an accumulation of the electric fluid as the horse does, and friction is necessary to develop it. The horn of the horse's hoofs seems to act as an insulator.

A New Telephone.—At the Royal Society in the close of May, 1880, a paper was read by Mr. Preece on some thermal effects of electric currents, in which he showed that extremely thin wires acquire and lose heat so rapidly and are so sensitive to linear expansion that, if inserted in the circuit of a microphone trans-

mitter, they reproduce sonorous vibrations. Thus, a mere sounding board or disc and a fine wire are all that are needed to reproduce speech with the same faithfulness that Bell obtains with electro-magnetic agency, Edison with electro-chemical agency, and Hughes with his microphone principle. The Preece telephone, if it do not prove so practical as other forms in use, has certainly carried simplicity of construction to its utmost limit.

Electric Perforation of Glass.—Professor Waltenhofen, of Prague, a short time since described some peculiar effects in electric perforation of glass. One experiment was as follows:—A circular ring of stearine is formed on a glass plate, and the points of the discharge are brought opposite each other at the ring's centre on the two sides of the plate; the plate is then perforated once at the inner border of the ring. But if the points are placed at equal distances from the centre, in the same diameter, *several* perforations occur at the inner side of the ring. Professors Mach and Donbrava have given some attention to these phenomena, and their experiments in general prove that the stearine ring offers a hindrance to the discharge, and that the stearine air surface insulates better than the glass-air surface (the glass surface being, relatively to the stearine surface, a conductor), and that perforation occurs at the border as at the place of greatest electric density. It is more difficult to understand the multiple perforation when the points are not opposite each other, and the single in the other. The

authors find this not to be of constant occurrence, and they offer (*Wiedmann's Annalen*) some experimental considerations on the subject.

Galvanic Batteries.—The study of galvanic batteries is now tolerably complete, and perhaps it is rather in minute examination of the reactions of liquids and metals, than in new combinations, that progress is to be sought. A fact of this order, recently observed by M. Pellat, is interesting. It relates to the effect of sunlight on batteries. A Daniell element, the copper of which is clean, is quite insensible to light, but it is otherwise if the copper be altered by oxidation or by formation of a salt on its surface. Two Daniell elements were prepared as a standard of electromotive force. The sulphates were contained in two concentric glass vessels, and communicated through the narrow space left between the emery stopper and the neck of the interior vessel. These elements, perfectly transparent, were kept five months; the zinc did not alter, but the copper was covered with a layer of verdigris. Still, the elements were found to have retained their original electromotive force, when this was measured in shade, but exposure to the sun diminished it by a quantity amounting to one-fortieth of its value. The variation was very rapid, and ceased whenever a screen intercepted the solar rays. The phenomenon was not due to rise of temperature, for immersion of the battery, in water at 50° , produced no sensible effect. A red glass which let half the calorific solar radiation pass,

had the effect of an opaque screen on the battery. On the other hand, a sky-blue solution, letting pass only the seventh of the calorific radiation, still transmitted a fifth of the effectual rays. Thus the phenomenon must be attributed to the more refrangible rays. Concentrating the solar rays with a lens on different parts of the battery, M. Pellat perceived that the altered copper contact and sulphate of copper are alone sensitive to the light. The copper became *less* positive; but if a copper wire oxidised in a Bunsen flame be put in a sulphate solution, and the pile be completed with unoxidised copper wire, insulation renders the oxidised copper *more* positive.

—*English Mechanic.*

Magnetic Disturbances.—An address was delivered before the British Association by Prof. W. Grylls Adams. In it he dealt with the subject of magnetic disturbances, and pointed out that in many instances the disturbances at the various stations of observations were not precisely alike, showing probably the change of the direction or intensity of the earth's magnetism arising from the solar action upon it. He believed there was a sufficient cause for all our terrestrial magnetic changes; for masses of metal were ever boiling up from the lower and hotter levels of the sun's atmosphere to the cooler upper regions, where they must again form clouds, to throw out their light and heat, and to absorb the light and heat coming from the hotter lower regions; then they became condensed and were drawn again back towards

the body of the sun, so forming those remarkable dark spaces or sunspots by their down-rush towards the lower levels. In these vast changes, which we know from the science of energy must be taking place, but of the vastness of which we can have no conception, we have abundant cause, for the magnetic changes which we observe at the same instant at distant points on the surface of the earth, and the same cause, acting by induction on the magnetic matter within and on the earth, may well produce changes in the direction of its total magnetic force, and alter the direction of its magnetic axis. These magnetic changes on the earth will influence the declination needles at different places, and will cause them to be deflected. The direction of the deflection must depend on the situation of the earth's magnetic axis, or the direction of its motion with regard to the stations where the observations are made. Thus, both directly and indirectly, we may find in the sun not only the cause of diurnal magnetic variations, but also the cause of these remarkable magnetic changes and disturbances over the surface of the earth.

How to Light Cities and Towns.

—The *Boston Herald* gives the following account of an American experiment made on September 2nd, 1880:—"A novel exhibition of powerful electric lights was made last evening in the vicinity of the Sea Foamhouse, Nantasket Beach, and the display was witnessed by quite a crowd of interested spectators. The Northern Electric Light Company have

erected three wooden towers, each 100ft. high, and mounted upon each of these a circular row of 12 electric lights of the Weston patent, each light being estimated at 2,500 candle-power. As these towers are but 500ft. apart and in a triangle, it will be seen that the light of 90,000 candles was concentrated within a limited territory. The design of the exhibition was to afford a model of the plan contemplated for lighting cities from overhead in vast areas, the estimate being that four towers to a square mile of area, each mounting lights aggregating 90,000-candle power, will suffice to flood the territory about with a light almost equal to mid-day. For this a motive power of 36 horses was used in generating the electricity from three Weston machines, and the lights, with one single slight flicker, burned steadily and brilliantly all the evening. It is difficult to say whether the experiment proved anything or not. The light was sufficiently brilliant to allow two base-ball nines to play in the centre of the field lighted a game of nine innings, with a score of 16 to 16; but, on account of the uncertain light (resembling that of the moon at its full), the batting was weak and the pitchers were poorly supported. A trip on the Nantasket Beach-road to Point Allerton, about a mile from the lights, showed that the rays were discernible even at that distance, though the intervening territory was but little affected beyond an eighth of a mile circuit. The lights appeared to illuminate a larger area on the water-side than on the land, the Sea View House

and its surrounding buildings affording a reflecting surface which largely increased the brilliancy of the display. The claim put forward by the company is for an original plan of lighting cities and towns by grouping and elevating electric lights of any kind."

A New Electric Candle.—A French inventor, M. Perruche, has presented a new description of electric candle to the Paris Academy of Science. The candle consists of three carbons, two being cylindrical and 0'004 mètre in diameter, and applied to each other, the third of square section, 0'005 mètre inside, and placed in the angle formed by the first two. The cylinders are in pivoted brass holders between brass plates, brought together by a spring. The holder of the square carbon is also capable of oscillation, and the carbon is held by a spring in contact with the other while no circuit passes, but when the current begins takes its separate position. It is regulated by an iron lever and electro-magnet in circuit.—*Electrician*.

Electrical Storage.—The feasibility of making a battery which should store electrical energy supplied to it from an ordinary battery or other source, to be given out afterwards as a current, has often been considered. Plante's now well-known secondary battery gives remarkable effects, but is open to some objections in view of various objects of electric storage, especially because of the lack of constancy and duration in the currents it evolves.

Two new proposals for electrical storage offering certain ad-

vantages have been lately made. Professors Houston and Thomson, of Philadelphia, construct a storage cell thus:—At the bottom of a vessel holding zinc sulphate solution is placed a copper plate, with insulated conducting wire, and near the top another copper plate with wire or one of carbon, or metal less positive than zinc, and unchanged by zinc sulphate. A porous diaphragm is fixed between. A current from a dynamo-electric machine is sent in the upward direction through the cell; this deposits zinc on the upper plate, and produces a dense solution of sulphate of copper over the lower one. The cell is thus charged, and continues a source of electric current until re-conversion of all the copper sulphate into zinc sulphate. Several such cells may be combined, and variously.

The authors represent that, supposing dynamo-electric machines realise in external work 50 to 60 per cent. of the power used in driving them, 50 per cent. of this may be stored and recovered; 25 per cent. of the original power being thus given out secondarily as electrical current. Only about 5 per cent. of the heat energy of the coal probably would be recovered after storage as electrical current; but the economy would be much superior to the use of zinc and other materials in the ordinary battery.

The other secondary battery to which we referred has been brought to the notice of the French Academy by M. D'Arsonval. He also uses sulphate of zinc solution, placing in it a zinc plate, or better, a layer of mer-

cury, and a plate of carbon surrounded with small shot (lead). The couple is charged by sending a voltaic current through it from the carbon to the zinc or mercury, the effect being deposition of zinc on the zinc, or amalgamation with the mercury and formation of peroxide of lead on the lead, the sulphuric acid remaining free. With a small couple of the kind, containing only 1 kilog. of small shot, he worked one of M. Deprez's useful little motors four hours. Where mercury is used the couple seems to retain its charge a long time. The *maximum* electro-motive force obtained was 2·1 volts.

Electric Lighting.—Professor Jamin gave an explanation and exhibition on the 4th of June, 1880, at Paris, of his system of electric lighting at the laboratory of the company formed for carrying it out. His plan consists in placing three or more candles in a lamp, one igniting when the other is burnt out, thus dispensing with the renewal of candles by hand every few hours, and an accident to one lamp does not affect others. He also claims to have considerably cheapened the production of the electric current, and to be able to increase or diminish the intensity at pleasure. The same advantages, it will be remembered, were claimed for the Lontin-Mersanne system, adopted by the Lyons Railway Company for their goods station at Paris.

New Uses for Electricity.—Dr. Siemens seems to be rivalling Mr. Edison in finding new applications for the electric current. In a paper lately read before the Society of Telegraphic Engineers,

he described and demonstrated by experiment some of his researches. In the first place he fused a kilogramme of steel in an electric furnace. He then proceeded to describe his experiments in electro-horticulture, affirming that the light from the carbon points was capable of reproducing chlorophyll in the leaves of plants, of aiding growth generally, and hastening the ripening of fruit. These experiments agree in their results with the observations made as to the growth of plants and fruits in northern Europe during the Arctic summer, when they are, of course, exposed to continuous light, from which it would seem that, unlike the animal creation, they require no hours of rest. Dr. Siemens intends during next winter to test his conclusions on a more elaborate scale, and for this purpose he has made suitable arrangements at his residence at Tunbridge Wells. The light is to be produced by a dynamo-electric machine driven by steam power in the ordinary manner. And special attention is to be paid as to the influence of the various rays in promoting the formation of starch, woody fibre, and chlorophyll. For this purpose plants in a darkened room will be subjected to a species of spectrum analysis, that is to say, they will be grown under the light of different portions of the spectrum. This plan has already been tried with sunlight without giving any definite results, principally owing to the fact that the luminary will not stand still. The author of the paper briefly alluded

to the electric railway recently tried at Berlin. It seems that the rails were insulated, and formed the two cables from a stationary machine which was worked by a steam engine. The locomotive, or driving carriage, contained another machine which was excited by the first, the electricity entering by one rail and returning by the other. It is suggested that this system may be available for working the line through the St. Gotthard Tunnel, the turbines which have been used during the boring operations furnishing the necessary power.

Application of Dynamo-Electric Machines to Telegraphy.—Experiments in the direction of using dynamo-electric machines in telegraphy have not hitherto been entirely successful; but a new arrangement, due to Mr. Stephen Field, of San Francisco, has been thoroughly tested in that city and in New York, and with satisfactory results. Previous efforts sought to accomplish the object by using a single high tension machine. The potential is now obtained by connecting one commutator brush of one machine with the brush of opposite polarity of the next, and so on, and a current of any desired potential may be had by taking it off from the different machines in the series. A current taken from the first machine in the series will have a low tension; that from the second a higher tension, and so on. The electro-motive force of the first machine in the series is 50 volts; in the second, 100 volts; in the third, 150 volts; in the fourth, 250 volts.

VIII.—CHEMISTRY.

The Spectra of Metalloids.—Dr. A. Schuster, F.S.A., read a paper before the British Association on this subject, and stated that he had considerable difficulty in distinguishing the spectrum of an element from that of a compound. For example, the familiar spectrum of a Bunsen's flame is ascribed by some to carbon, and by others to a hydrocarbon, the argument in favour of the latter view being that the temperature of the flame is not sufficiently high to volatilise carbon as such. The reply to this argument is that during its passage from its compound with hydrogen to CO or CO², the element carbon is actually liberated, and then exhibits the band spectrum; and in confirmation of this theory it has been noticed that gas impregnated with the salt of a metal such as copper or iron, gives, in the Bunsen's burner, the true metallic spectrum and not the spectrum of a compound. The same argument applies here, for the metal is actually liberated during its passage from (say) the chloride to the oxide. Besides, the band spectrum is seen still more effectively when cyanogen is burned, even when dried as perfectly as possible. This band spectrum is seen in the sun's rays, and it is highly improbable that cyanogen should be able to resist such an enormously high temperature.

The author then considered the

question—Why should an element give different spectra at different temperatures? Bands are characteristic of compounds, and at low temperatures elements show a banded spectrum. At higher temperatures such spectra become simpler, and the evident conclusion is that complex molecules of the elements are dissociated into those of a simpler order.

This view is rendered highly probable by the fact that the spectrum of mercury is a constant one, and that no known increase of temperature alters its character; now, assuming the molecule of hydrogen to consist of two atoms, that of mercury consists of a single atom, and it is evident that no simplification is possible. The change of the spectra of chlorine, bromine, and iodine, as the temperature is increased, would seem to corroborate Prof. Victor Meyer's recent conclusions with regard to the molecular complexity of these elements. It was also suggested that the spectrum of an element might vary according to the nature of the compound from which it is liberated. Were it possible to decompose carbon monoxide and dioxide, and to obtain the spectrum of the single carbon atoms which they contain, it would probably differ from the well-known banded spectrum of carbon which there is reason to suppose is that of at least a two-atom molecule.

On the Ultra-Violet Spectra.—Professor A. K. Huntington, before the Chemical Section of the British Association, drew attention to the following points:—The late Dr. Miller, in his experiments, was obliged to conclude that no connection could be drawn between the chemical composition of a substance and its power of absorbing ultra-violet rays. His method of experimentation, however, was deficient, inasmuch as he used layers of varying thickness, and in every case employed saturated solutions. His substances were not so pure as is necessary in such an investigation.

Dr. Miller also investigated the absorption of the ultra-violet rays by reflection from polished metallic surfaces. The results obtained were that gold shows almost total reflection; next best is burnished lead. Other metals present a greater or less absorption. Professor Stokes' results confirm Dr. Miller's. His process differed from that of Dr. Miller, inasmuch as he passed the light through a layer of the solution of the substance under experiment on to a fluorescent screen, while Dr. Miller photographed the spectrum. His results were of great value, and, from a chemical point of view, it is of interest to note that glucosides and alkaloids have great absorptive power, and that on addition of acids, absorption begins somewhat later than in the presence of an alkali.

In 1874 Mr. Sorby constructed a spectroscope with a fluorescent eye-piece, and was thus able to observe the spectra directly. His results, though valuable, are

vitiated by the impurity of the material he used. Mention must also be made of experiments by Professor Cordieu, who experimented on the influence of the atmosphere in cutting off rays on the ultra-violet end of the spectrum.

Professor Hartley, one of the members of the Committee, has recently experimented on this subject, and some of the results of his researches have been communicated to the Royal Society. His experiments, made with an improved form of Dr. Miller's apparatus, have led to interesting conclusions. He has found that monatomic alcohols of the methyl series exhibit little or no absorption. The first of the series, methyl alcohol, is, when pure, quite as "diaphanous" as water to invisible rays. Fatty acids, containing the same number of atoms of carbon as the alcohols to which they are related have a higher absorptive power. Increased complexity of the molecule causes increased absorption.

All members of the benzene series, in fact all bodies whose constitution is best expressed by the "ring formula," give absorption-bands of great intensity; the hydrocarbons themselves, however, occupy the lowest position in this respect. Isomeric bodies of this group differ widely in their spectrum, which thus affords a convenient means of identification. Doubly-linked bodies, such as ethene, propene, allylene, give no absorption-spectrum; and in fact the ring form appears to be a *sinc quā non*, for the terpenes and camphor do not absorb ultra-violet rays. The in-

tensity of the absorption bands of naphthalene and anthracene is remarkable; a solution of one part of the latter body in 50 million times its weight of acetic acid may still be recognised.

The Effect of Magnesia on Vegetation.—Major-General Scott's paper, read before the British Association, on the effect of magnesia on vegetation, deserves the attention of agricultural chemists and farmers; the soil, he maintains, would be much benefited by a supply of magnesia, just as it is by phosphoric acid.

On Saccharine.—By action of alkalis on glucose, M. Périgot has obtained a substance, the formation of which will probably throw some new light on the composition of saccharine matter. It seems to have escaped the notice of chemists hitherto. With the composition of ordinary sugar, or saccharose, it is nevertheless not sugar. In presence of beer-yeast, it does not ferment; its taste is not at all sugary, but almost *nil*, with a slight after-bitterness (recalling Glauber's salts). M. Péligot calls it *saccharine*.

The mode of preparation is as follows:—To a solution of glucose and lime, which has been boiled and filtered, enough oxalic acid is added to precipitate the lime as calcareous oxalate. After filtering to separate the latter, and evaporating to syrupy consistence, a crystalline magma is ere long obtained, the solid matter emasted in a sort of molasses, which may be absorbed by means of unsized paper. The colours are redissolved in hot water, and the yellowish liquor is made colourless with bone-black. By

spontaneous evaporation, this solution gives large rhomboidal prisms of saccharine.

It has been pointed out by M. Berthelot that the new substance presents notable resemblances, in general reactions and crystalline form, to trehalose. Among other points, both are more stable than other saccharoses; but saccharine is more stable than trehalose, for it resists the action of concentrated sulphuric acid at a high temperature.

The Poisonous Properties of Arsenic.—What is the chemical cause of the poisonous properties of arsenic? Liebig at one time offered a theory on the subject, to the effect that arsenious acid and corrosive sublimate have in very high degree the power of forming solid combinations with albumen, and when taken internally, they thus render the albumen of living tissue incapable of undergoing the transformations necessary to it, simply extinguishing the life of important parts. This view, however, though it still appears in some handbooks, Liebig gave up.

In a recent note on this question to the Berlin Chemical Society, MM. Binz and Schulz point out that, in arsenic poisoning, it is precisely those tissues which are specially adapted to absorb and work up the *oxygen* of the blood (especially the protoplasm-glands) that are the seat of the destruction. Now, arsenious acid can easily be changed into arsenic acid, while arsenic acid is transformed still more easily into the other. The latter process is effected by albumen generally, the former by *living* albumen of animals and plants. From various

experiments, the authors conclude that by reason of this transformation of the two acids into each other within the living albumen-molecule, causing a vigorous to-and-fro displacement of the oxygen atoms, the tissues are corroded and completely destroyed. Between arsenic and nitrogen there is an exact parallel in this respect. Nitrous oxide is very poisonous. By taking up oxygen, it is changed into the violently-oxidising hyponitric acid. It destroys the tissues, while, by taking up water, it can be partly transformed again into nitrous oxide. In the whole process, the nitrogen has no direct action ; it is merely the inert carrier and distributor of the active oxygen atoms. The same rôle is played by arsenic as a carrier of active oxygen, i.e., there is a constant change going on from arsenious to arsenic acid, and vice versa.—*English Mechanic.*

The Reduction of Aluminium.—Mr. J. W. Kynaston read a paper before the British Association on “A New Process for the Production from Aluminous Minerals containing Iron of Aluminium Sulphate free from Iron.” After a preliminary sketch of the various methods of preparing sulphate of alumina in a state of greater or less purity from various minerals containing it, Mr. Kynaston described his own process of preparing it from bauxite, a silicate of titanate of alumina and iron. This he does by treating it with a mixture of oxalic acid and hydrochloric acid. Allowing it to stand for a week or ten days, the insoluble portion was freed from oxalic acid by repeated washing, and the residue was converted

into sulphate of alumina. The oxalic acid was recovered by precipitation with lime, and subsequent decomposition of the lime salt in sulphuric acid. The expense of this process had prevented its adoption.

The speaker had devised a process whereby the iron was precipitated as arsenite, and then by means of carbonate of lime neutralised in free acid, some tetrabasic sulphate of alumina being at the same time produced. The remaining ferrous iron was then removed by the addition of ferrocyanide of lime. The blue precipitate was induced to settle by the addition of a little sulphate of iron or zinc. The excess of arsenic was precipitated with sulphate of lime. This process was at present in operation at St. Helen’s.

Notes on Petroleum Spirit and Analogous Liquids.—In his paper on this subject, read before the British Association, Mr. A. H. Allen said to distinguish petroleum spirit from shale naphtha and from benzene, mix one volume of boiled carbolic acid with three volumes of these liquids. The carbolic acid refuses to mix with the former, but mixes with the two latter. On similar treatment with coal-tar, pitch, petroleum spirit and shale naphtha do not mix, whereas benzene does. With carbolic acid, burning oil from shale can be distinguished from kerosene, the burning oil from petroleum, for the former is not miscible, whereas the latter turns violet, and partially mixes ; and if warmed, crystals of carbolic acid separate on cooling. By treatment with nitric acid and

with bromine, it was shown that naphtha from petroleum contains 80 per cent. of paraffins and 20 per cent. of olefines; photogene, 55 to 80 per cent. of paraffins, and that wax consists entirely of paraffins; whereas shale naphtha contains 75 to 90 per cent. of olefines; photogene from the same source, 60 to 65 per cent. of olefines, and that the lubricating oil consists entirely of olefines.

Artificial Diamonds.—In the course of researches "On the Solubility of Solids in Gases," which formed the subject of two papers read before the Royal Society, the author, Mr. J. B. Hannay, of Glasgow, conceived the possibility of finding a solvent for carbon. A gaseous solution nearly always yields crystalline solid on withdrawing the solvent or lowering its solvent power; it was, therefore, probable that the carbon might be deposited in the crystalline condition. Many experiments were made, but they showed that ordinary carbon, such as charcoal, lampblack, or graphite, is not affected by the most probable solvents that could be thought of, for chemical action takes the place of solution.

During these experiments Mr. Hannay noticed a curious reaction, namely, when a gas containing carbon and hydrogen is heated under pressure in presence of certain metals the hydrogen is attracted by the metal, and the carbon is left free. When this takes place in presence of a stable compound containing nitrogen, the whole being near a red heat and under several thousands of atmospheres of pressure, the carbon is so acted upon by the

nitrogen compound that it is obtained in the clear, transparent form of the diamond. The great difficulty lies in the construction of an enclosing vessel strong enough to withstand the enormous pressure and high temperature, tubes constructed on the gun-barrel principle (with a wrought-iron coil), of only half-an-inch bore and four inches external diameter, being torn open in nine cases out of ten.

The carbon obtained in the successful experiments is as hard as natural diamond, scratching all other crystals, and it does not affect polarized light. Crystals have been obtained with curved faces belonging to the octahedral form, and diamond is the only substance crystallising in this manner. The crystals burn easily on thin platinum-foil over a good blow-pipe, and leave no residue, and after two days' immersion in hydrofluoric acid they show no sign of dissolving, even when boiled. On heating a splinter in the electric arc it turned black—a very characteristic reaction of diamond.

Lastly, a little apparatus was constructed for effecting a combustion of the crystals and determining their composition. The ordinary organic analysis method was used, but the diamond crystals were laid on a thin piece of platinum-foil, and this was ignited by an electric current, and the combustion conducted in pure oxygen. The result obtained was that the sample (14 mgrms.) contained 97·85 per cent. of carbon, a very close approximation, considering the small quantity employed.

The announcement that the long predicted experiment — artificial formation of diamond — would be described at a meeting of the Royal Society occasioned much excitement; but neither dealers in diamonds nor the general public need disturb themselves. The process is expensive, tedious, and dangerous, and the diamonds produced as yet are too small to represent anything beyond a scientific value. Cheap diamonds made by machinery are reserved for some future generation.—*Athenaeum*.

More about Artificial Diamonds.—Mr. J. B. Hannay, in a recently-issued number of the "Proceedings of the Royal Society," published an account of the precise method by which he obtained his artificial diamonds. If only as a record of indomitable perseverance against ever-increasing difficulties, of scientific acumen, and of the true application of the Baconian method of research, it is worthy of study. Some idea of the nature of the investigation may be obtained from the fact that out of eighty complex and expensive experiments only three succeeded. Violent explosions were frequent; furnaces were blown to pieces; steel tubes burst, scattering their fragments around. On other occasions tubes which had been carefully prepared, filled, welded, and nested in a reverberatory furnace for many hours were found to have leaked, and spoiled the experiment. "The continual strain on the nerves," writes Mr. Hannay, "watching the temperature of the furnace, and in a state of tension in case of an explosion, induces a nervous state burst with an explosion like a

which is extremely weakening, and when the explosion occurs it sometimes shakes one so severely that sickness supervenes."

The diamond-making experiments were started in September, 1879, when Mr. Hannay made many attempts to find a solvent for the alkali metals, sodium, potassium, and lithium. But in no instance could such a solvent be found which did not in the gaseous state, and under pressure, unite with the alkali. Even in the case of hydrocarbons, such as paraffin spirit containing only hydrogen and carbon, the alkali combined with the hydrogen, setting free the carbon. Now, as we know, diamond is pure carbon; hence, when this element was set free from a pure substance, it was thought that conditions of pressure and temperature might eliminate it in the hard, crystalline, adamantine form, viz., as diamond. Glass tubes were first employed, but although of great thickness in comparison with their bore, they were found to be insufficiently strong, and they were replaced by wrought-iron tubes 20 inches long by one inch diameter, and having the diameter of the bore half an inch. In these lithium was heated for many hours to a high temperature in paraffin spirit, and on subsequently opening the tube carbon in a hard form was found within it.

Great difficulty was experienced in getting the tubes perfectly air-tight, and eventually the open end was welded, at a white heat, and by that means alone did it resist leakage. Sometimes tubes would

In. A tube 20 inches long by $\frac{1}{2}$ diameter and half-inch bore was filled with a hydrocarbon made from bone oil, to which some charcoal powder was added in order to keep an excess of carbon in the tube. Its open end was welded, and it was heated for 14 hours with lithium. On opening it a quantity of gas appeared and some minute pieces of hard carbon, which had evidently separated out from solution. Another similar tube burst at the end of 8 hours' heating. A tube of cast iron no less than $3\frac{1}{2}$ inches diameter, and with a bore of only three-quarters of an inch, exploded at the end of an hour with a fearful report, wrecking the furnace. Several tubes of steel also burst under the enormous pressure, at last shattering the top of the furnace.

The author remarks that in nature the temperature must at one time have been much higher than anything we can now produce artificially, while the pressure obtained at a depth of 200 miles below the earth surface is greater than that which any of the materials from which we can form vessels can resist. We come now to the great experiment which resulted in the artificial production of veritable diamonds. A tube 20 inches long by 4 inches diameter, of coiled Lowmoor iron, was bored so as to have an internal diameter of half an inch. Thus the central bore was surrounded by walls of iron $1\frac{1}{4}$ inch thick, and, of course, capable of resisting an enormous pressure. In the tube was placed a mixture of 90 per cent. of rectified bone oil, and 10 per cent.

of paraffin spirit, together with 4 grammes (about 62 grains) of the metal lithium. The open end of the tube was welded air-tight, and the whole was then heated to redness for 14 hours, and allowed to cool slowly. On opening it a great volume of gas rushed from the tube, and within was found a hard, smooth mass adhering to the sides of the tube.

"It was quite black, and was removed with a chisel, and as it appeared to be composed principally of iron and lithium, it was laid aside for analysis. I was pulverising it in a mortar when I felt that some parts of the material were extremely hard—not resisting a blow, but hard otherwise. On looking closer I saw that these were most transparent pieces embedded in the hard matrix, and on triturating them I obtained some free from the black matter. They turned out to be crystalline carbon, exactly like diamond."

Such is Mr. Hannay's account of his discovery. Subsequent chemical and optical analysis has proved that these hard, shining crystals are in every respect true diamonds. The cost is obviously great; so also, is the danger to life and property; and the great difficulties to be overcome render disappointments common. What we now want is to get vessels of a material sufficiently strong and non-porous to resist the high pressures and temperatures upon which the success of the experiment depends.

What we have learnt, among other things, from the brilliant researches of MM. Caillelet and Pictet, which led to the liquefaction of the so-called permanent

gases, and from Mr. Hannay's experiments described above, is that we must push the forces of nature to their utmost strain by using our most powerful mechanical devices for producing pressure, our strongest materials for resisting it, and our intensest means of producing both heat and cold. Never was the Baconian aphorism —*occulta naturae magis se produnt per vexationes artium quam cum cursu suo meant*—more applicable than to experiments of the nature of those which Mr. Hannay has so ably carried out, and which have led to the production of a substance which had hitherto kept the secret of its formation securely shut up in the bowels of the earth.—*Daily News*.

Zinc Ores.—Mr. E. A. Parnell read a paper before the British Association on "A New Process for the Metallurgic Treatment of Complex Ores Containing Zinc." In explaining the process Mr. Parnell said that after having been ground sufficiently to pass through a sieve of six or eight holes to the linear inch, the ore was calcined, with exposure to the air, at a moderate heat. This calcination was effected in muffle furnaces, the gas from which, when containing a sufficient proportion of sulphurous acid, or making sulphuric acid, being conveyed to leaden chambers for that purpose. The sulphides and the various metals were thus converted into oxides and sulphates. A dull red was found by experience most favourable to the formation of sulphate of zinc, but it had to be of sufficient for the decomposition of ferrous and ferric sulphates.

The calcined ore was next mixed cent. of zinc, the oxide, as with-

with weak sulphuric acid in a revolving pan lined with lead, invented by Mr. J. W. Chenhall; neutral liquors were first run off, afterwards excessive acid was introduced, and the acid liquors thus obtained were used for reproducing neutral liquors from a fresh charge of the calcined ore. The solution of sulphate of zinc thus obtained, of course, contained copper, when that metal was present in the ore. Of iron it contained very little, provided the ore had been properly calcined so as to peroxidise all the metal. When sulphuric acid combined by preference with oxide of zinc, the clear neutral liquor was next precipitated in the usual way, either as metallic copper by means of iron or zinc, or as sulphate. The solution of sulphate of zinc was then concentrated by evaporation, and on being mixed with finely ground blonde, in the proportion of one equivalent to three equivalents of zinc sulphates, it began to thicken. This mixture, after being further tried, was lastly heated in a muffle furnace.

The neutral reaction he had already described took place with the production of oxide of zinc and sulphurous acid. The latter taking no admixture of gases derived from the fire was conveyed to leaden chambers for the reproduction of sulphuric acid. The oxide of zinc thus obtained was in a condition well suited for the manufacture of metallic zinc in the ordinary way. Its strength and purity, of course, depended, to some extent, on that of the blonde used as a reducing agent; when the latter contained about 45 per

drawn from the furnace, contained about 62 per cent. of zinc. It contained no impurity which was any inconvenience in its application in the making of metallic zinc. The principal impurity was oxide of iron derived partly from the blende added in the process, and partly from the use of iron as a precipitant for the copper. The impurity which the zinc manufacturer regarded as most deleterious, viz., lead, was reduced to a minimum, being only

small proportion contained in the blende added. The same might be said respecting calcium. The residue consisted of lead sulphate and silver chloride. By the ordinary treatment it was converted into argentiferous metallic lead.

Agricultural Chemistry.—The address in the Chemical Section of the British Association was delivered by the president, Dr. J. H. Gilbert, F.R.S., who referred mainly to the subject of agricultural chemistry, and in the course of his remarks said, referring to the assimilation of carbon, that the whole tendency of observations was to conform to the opinion put forward by De Saussure about the commencement of the century, and so forcibly insisted upon by Liebig, 40 years later, that the greater part, if not the whole, of the carbon was derived from the carbonic acid of the atmosphere.

Judging from more recent researches, it would seem probable that the estimate of one part of carbon or carbonic acid in 10,000 of air was more probably too high than too low as an estimate of the average quantity in the atmosphere of our globe. Large as was the annual accumula-

tion of carbon from the atmosphere over a given area, it was obvious that the quantity must vary exceedingly with the variation of climatical conditions. It was, in fact, several times as great in the case of the tropical vegetation—that of the sugar-cane, for instance. And not only was the greater part of the assimilation accomplished within a comparatively small portion of the year, but the action was limited to the hours of daylight, whilst during darkness there was rather loss than gain. In a general sense it might be said that the success of the cultivator might be measured by the amount of carbon he succeeded in accumulating in his crops. And as the amount of carbon accumulated depended on the supply of nitrogen in an available form within the reach of plants, it was obvious that the question of the sources of the nitrogen of vegetation was one of first importance.

The result of experiments that had been conducted went to prove—first, that without nitrogenous manure, the gramineous crops annually yielded for many years in succession, much more nitrogen over a given area than was accounted for by the amount of combined nitrogen annually coming down in the measured aqueous deposits from the atmosphere; second, the roots yielded more nitrogen than the cereal crops, and the leguminous crops much more still; and third, that in all cases—whether of cereal crops, root crops, leguminous crops, or a rotation of crops—the decline in the annual yield of nitrogen,

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when one was supplied, was very great.

The next point referred to was the condition of the nitrogen in our various crops. They could not say that the whole of the nitrogen in the seeds with which they had to deal existed as albuminoids. But they might safely assume that the nearer they approached to perfect ripeness the less of non-albuminoid nitrogenous matters would they contain; and in the case of the cereal grains, at any rate, it was possible that if really perfectly ripe they would contain very nearly the whole of their nitrogen as albuminoids.

With regard to some leguminous and other seeds, which contained peculiar nitrogenous bodies, the range might, however, be wider. But whatever the condition of the nitrogenous bodies in the seeds they grew or sowed, with germination began a material change. Albuminoids were transformed into peptones, or peptone-like bodies, or degraded into various compounds. The question arose, therefore, whether these bodies contributed in any way to the nutrition of the animals which fed upon them. They had but little experimental evidence on that point. As green herbage was the natural food of many descriptions of animals, they might suppose that characteristic constituents of it would not be without some value as food; but the cultivated root crops were much more artificial productions, and it was in them that they found such a very large proportion of non-albuminoid nitrogen.

The Spectra of Gases.—Dr. Schuster gave a short account, at

the meeting of the British Association, of a report on the influence of temperature and pressure on the spectra of gases delivered by a committee appointed in 1879, to report on the present state of spectroscopy. The curious fact was mentioned that whenever a line widened more on one side than on the other that side was the less refrangible part of the spectrum. The next subject discussed was the phenomenon of multiple spectra. Wherever we knew that a change of density occurs in a gas a change of the spectrum is observed, and it seemed probable that the inverse conclusion holds good, and that wherever we observe a change in the spectrum a change in the density will hereafter be proved to take place. Some years ago Mr. Lockyer investigated a method of projecting the image of the spark on the slit of the spectroscope. Some curious facts were discovered in this way; some of the lines were found to be nearly confined to the electrodes, and others to stretch far away from the pole. The longest lines are by no means always the strongest, and this is a point often misunderstood, even by spectroscopists. We can, by means of Mr. Lockyer's method, generally foretell how a spectrum will behave when the temperature is lowered or increased. Recent experiments of Professors Liveing and Dewar have confirmed the laws given by Mr. Lockyer. Dr. Schuster referred to two rival hypotheses put forward to explain the phenomena, and they did not exclude each other, but might have to be taken into account in order to explain all the phenomena.

IX.—MEDICAL SCIENCE.

A Cooling Coverlet. — It is known that treatment by refrigeration is often resorted to, in cases of typhoid fever especially. Dr. Dumontpallier has lately introduced at the Hôpital de la Pitié a new apparatus for the purpose, made under his direction by M. Galante. It is described in *La Nature*. The coverlet is formed of a tube of caoutchouc 80 mètres long, bent to and fro in a series of equal lengths, and enclosed between 2 pieces of cloth. The tube is traversed throughout by a current of cold water, its 2 ends communicating with a distributing apparatus placed on a table at the foot of the bed. This apparatus comprises 2 stop-cocks in a parallel position, each with an adjoining cylindrical metallic case, from which the stem of a thermometer projects. The stop-cocks are connected with the 2 ends of the coverlet tube, and the cases are connected on the other side, one with the tube from a reservoir, the other with the tube of outflow for the water that has been used. The tube from the coverlet to the stop-cock of outlet is arranged to send the water through a small glass bell jar on the table, which enables one to observe the regularity of the flow, while the thermometers indicate the temperatures at which the water enters and leaves the coverlet. The apparatus is said to be highly sensitive; a slight alteration of the orifice of one or other of the stop-cocks, or of both simultaneously, is followed almost immediately by thermometric variations. The weight of the patient has, of course, no influence on the flow of liquid, which is effected with excellent regularity.

Vital Statistics. — A Parliamentary return recently published gives particulars as to the mortality in England and Wales during certain periods from 1838 to 1877. From these statistics it appears that from 1838 to 1853 the average annual death-rate (all ages and causes) per million of population was 22,386; from 1838 to 1853, excluding 1846 to 1849—the cholera period—21,840; from 1854 to 1877, 22,141; and from 1868 to 1877, 21,847. In 1847 the number of deaths of children under 1 year was, from all causes, 164,425 per million, and of children from 1 to 5 years of age, 166,354; while in 1877 the total under 1 year was 136,025, and between 1 and 5, 151,364. From 1847 to 1853 inclusive, the proportion of deaths of all ages from small-pox was 305 per million; and from 1868 to 1877 inclusive it was only 261. A note appended to the latter returns explains that during the 12 years, 1838-42 and 1847-53 (the only years prior to compulsory vaccination for which these mortality statistics are available), the average annual

death-rate from small-pox was equal to 420 per million persons living; whereas in the 25 years (1853-78) of compulsory vaccination the annual death-rate from this disease has not averaged more than 216 per million, notwithstanding the exceptionally fatal epidemic of 1871-2.—*British Medical Journal*.

Domestic Poisons.—At a meeting of the Society of Arts, in January, 1880, a paper by Mr. H. Carr on "Domestic Poisons" was read. Limiting his attention to poisonous materials used in manufactures and allowed to remain in the finished goods, the author treated the subject as affecting both the public and the trades. The principal offenders put on their trial were arsenical pigments in wall-papers; arsenical dyes in cotton fabrics, such as curtains, chintz, tarlatan, &c.; in artists' water-colours and common paint; poisonous colours dusted on in lithographic printing and in tin-plate work. Poison was also introduced in artificial flowers, lamp shades, fly papers, cardboard boxes, and labels. Paper collars and cuffs were said to be sometimes arseniated, but the indictment had not been sustained. The symptoms of domestic poisoning were minutely described and illustrated by a number of typical cases. The allegation that the deleterious character of the pigments in question had been greatly exaggerated was examined at some length, and ultimately dismissed. An imposing amount of medical testimony was adduced to prove the danger only too real. The trade interests supposed to be involved were investigated, and the alleged advantages of the use of arsenic for wall papers, &c., were shown to be for the most part imaginary. Some paper-stainers had abandoned the use of arsenical pigments, and there could be no doubt that they were gradually becoming disused. The trade circulars of the manufacturers were quoted to prove that the tide of public opinion had already turned strongly against these "domestic poisons." The foreign trade was the main difficulty in dealing with the question. The production of arsenic in this country was on a scale that would surprise most people when it was borne in mind that 2 or 3 grains would destroy life. An output of 4,809 tons, valued at £30,420, in 1 year, was the yield of the mines, which were 20 in number, all situated in Cornwall and Devon. For meeting the evil the remedy suggested would be a law prohibiting the use of arsenic in the manufacture of all fabrics for domestic use—that is, in all those processes which leave the arsenic in the finished goods.

Human Refrigeration.—Some experiments which seem to throw light on the physiological effects of bathing have been recently made by Dr. Paul Delmas, of Bordeaux. The action of cold and heat on the human system was studied by subjecting the whole body, except the head, of a healthy and robust subject to refrigeration with water at +10deg. C., in a suitable apparatus, the time of exposure varying from 15 seconds to 5 minutes. In some cases heat was applied previously. The

pulse and temperature were noted all the time, and every 5 minutes in succeeding hours; the temperature by means of a thermometer placed in the mouth. The following effects were observed:—During application of the cold, while the subject shows every sign of very intense sensations (painful or otherwise), the temperature of the body scarcely varies at all, or varies at most 1 to 2-10ths of a degree, from that noted before; and previous heating does not affect this result.

If, immediately after the application of cold, the subject remain perfectly still after having been carefully dried and dressed, so as to avoid all active muscular movement, the temperature still varies little or not at all; but if he exert himself actively (in dressing, running, or walking), either immediately after the cold application or after a time of immobility, so as to bring on all the external phenomena of cold-reaction, the temperature suddenly falls. The reduction persists several hours, and is more pronounced the stronger the sensation of heat in the subject. On the other hand, if chill continue or re-appear, owing to long immobility or suspension of exercise, the animal temperature does not fall, or immediately rises again. The amount of lowering of the temperature 2 or 3 hours after a cold application was, in 11 cases out of 12, 0·1 deg. to 0·6 deg. The maximum in a very vigorous subject never exceeded 1·3 deg. At the commencement of the cold application the pulse suddenly becomes very quick; after 10 to 15 seconds the velocity rapidly diminishes; and at the

end of the experiment has returned to the previous figure or below it. If the subject, carefully dried and dressed, keep quiet, the retardation of the pulse stops or progresses slowly; but in the opposite case it is very pronounced and persists the more the subject gives signs of energetic reaction and a general sensation of heat. Two or 3 hours after the cold application the pulse showed (in 11 cases out of 12) 2 to 20 pulsations fewer than before the experiment.

A Fast for Forty Days.—During the month of July and the early part of August, a certain Dr. Tanner, an American, fasted 40 days and 40 nights. This tremendous feat was performed nominally in the interest of science, but nobody has yet found the point where science would be benefited by the experiment; and the great fast has failed to make clear the motive which actuated him in his marvellous undertaking.

Effect of Starvation on the Blood.—During the last hour of Dr. Tanner's fast, some of his blood was withdrawn and examined in the microscope by Dr. Van der Weyde. It proved to be quite different from healthy blood. The corpuscles, which are usually smooth and round flat discs, with a central depression, were found to be ragged, irregular, and shrunk (on an average) from 1-3600th to 1-5000th part of an inch in diameter. There was scarcely a smooth corpuscle among them. The white corpuscles, however, were smooth, and nearly of normal size; and their proportion to the red was apparently increased

to about 1 in 100 (the normal being 1 in 400). The rough appearance of the red corpuscles was due to projecting points, thought to represent a fungoid growth going on at the expense of the corpuscle (those most densely covered being the smallest and most irregular in shape). Such growths have been observed on the corpuscles of patients suffering from various malarious diseases. Twenty-four hours after Dr. Tanner had broken his fast it was observed that many smooth and fresh corpuscles had been evolved. At the second day about half of the blood had become normal, while on the third day nearly all the corpuscles were of the normal kind.

A Simple Instrument for the Deaf.—Accounts have been published of an instrument called the audiphone, the device of Mr. Rhodes, of Chicago, whereby deaf mutes are enabled to promptly distinguish musical sounds of some instruments, and even vocal articulations, and with the aid of which their oral education can be considerably abridged; it is also useful to persons merely deaf. The form is like that of a fire-screen, to be held in the hand; the material of the screen proper, or "disc," being hardened rubber, and the rounded part opposite the handle being curved round slightly, and held in a tense state by a branching cord from the handle. The middle of the curved part is applied to the teeth of the upper jaw. Considering the rather high price of such instruments, also that their possible dimensions are somewhat limited, and that hardened rubber is fragile in cold weather, M. Colladon, of

Geneva, after testing the usefulness of the audiphone, has tried various other materials, and has at length hit upon a variety of thin pasteboard, which gives the same results as the hardened rubber. The material is known in France as *cartons à satinier*, or *cartons d'orties*, in England as shalloon boards. They are very compact, homogeneous, and tenacious; they are also very supple, and, provided their thickness do not exceed 0'001m., a slight pressure of the hand maintaining a disc cut from one of these cardboards, with its convex extremity applied to the upper teeth, suffices to give it sufficient curvature, variable at will, without fatigue for hand or teeth. The part of the card applied to the teeth may be made impermeable to moisture by means of a varnish. The handle and the cord to produce the necessary tension in the other audiphone are dispensed with, and the instrument is obtainable for 50 centimes, instead of 50 francs. The instrument was tried *inter alia* with 8 deaf mute pupils of M. Sager. The distance being first determined at which they ceased to be affected by the sounds of a grand piano, they were supplied with the audiphone, and the sensation of the sound was then distinctly perceived. Blindfold they could distinguish the high notes from the low ones, and the notes of the piano from those of a violoncello. Words pronounced very near the audiphone could be perceived by the deaf and dumb, and in some cases repeated. It is also noteworthy that deaf mutes who were enabled to hear the notes of a piano for the first time,

derived genuine pleasure from them. These card audiphones can also be utilised by persons whose hearing is affected, and who find it troublesome to support acoustic instruments at the ear.

Effects of Inhaling Oxygen.—A young Frenchman, M. Aune, has lately made experiments on himself relative to this question, which he has chosen as the subject of a medical thesis. The experiments lasted 4 weeks, during which time he submitted himself to a uniform *régime* as regards quantity and quality of food, muscular exercise, and intellectual work. He took oxygen only during the second and the third week, inhaling between 40 and 80 litres of it daily, but during the whole time he made a careful record of temperature, pulse, respiration, &c. The conclusions arrived at are briefly as follows:—Inhalations of oxygen made under physiological conditions do not cause any inconvenience. One may absorb 100 litres, and even more, daily. Oxygen increases the appetite, and develops the functions of assimilation; and on this account it tends to increase the weight of the body. It produces a slight intoxication, and tingling sensations in the extremities. It raises the temperature very slightly. Under its influence the respiratory movements and the pulsations become more numerous. The emission and reaction of the urine are not affected, nor is its constitution. Oxygen has no incontestable action on certain elements of the blood; it increases the number of red corpuscles and of hematoblasts, and the richness of the states. Two distinct groups ap-

former in hemoglobin. It has no influence on the white corpuscles. M. Aune did not experience that sensation of heat in the chest of which some authors have spoken in connection with this subject. Commenting on M. Aune's experiments, M. Hoyem remarks that the effects are only temporary, and that while inhalation of oxygen may be of service through favouring assimilation, it could not be made a definite treatment, and it would be necessary always to administer iron in addition. The inhalation gives very good results in the case of dyspeptic phenomena and obstinate vomiting.

Clothing in Relation to Health.—In the practical working out of his views on health (which seem to gain in favour with German scientists), Professor Jaeger of Stuttgart commends so-called normal clothing, which (1) consists exclusively of wool, and (2) is especially arranged to keep warm the middle line of the front of the body. The general object is to prevent accumulation of fat and water in the system; the author's leading principle being, that the greater the specific gravity of the human body the more it is able to resist epidemic diseases. To the well-known properties of wool, as regards moisture and heat, Professor Jaeger makes a curious addition. He claims to prove that in our organism there are certain gaseous volatile substances—*Duftstoffe* (odorous substances), which are continually being liberated in the acts of breathing and perspiring, and have important relations to mental

pear, those—viz., of *Lust* and *Un-lust Stoffe* (substances of pleasure and disliking); the former are exhaled during a joyful and pleasant state of mind, and produce this state with heightened vitality if inhaled. Of the latter the reverse is true. It may be readily verified that during joy and happiness the odour of perspiration is not disagreeable, while during anguish and great nervous excitement it is offensive. The substances of disliking have therefore a bad odour; and in an atmosphere of them the vitality is lowered; hence, in a state of anguish and fear the body is more susceptible to contagious diseases. Now, Professor Jaeger contends that sheep's wool attracts the "substances of pleasure" (and this is distinct from its great odour-absorbing capacity in general), while clothing made of plant-fibre favours the accumulation of the offensive substances of dislike with their evil consequences. A large amount of experimental evidence is adduced in support of these views. The experience of the many persons who have adopted his normal clothing, both for summer and for winter, is stated to be very satisfactory.

Vaccination and Small-pox.— Mr. Ernest Hart delivered a lecture on this subject in January, 1880, under the auspices of the National Health Society, at a public meeting held in the theatre of the Society of Arts, Adelphi. Mr. Hart commenced his lecture by stating that, having been asked for information with regard to the statements of the anti-vaccinators, he had been able to refer his enquirers to the standard

works on the subject and to statistics of the Registrar-General; but what seemed to be wanted was some plain, practical, and direct answer to the specific allegations of the anti-vaccinators. He set himself to prepare such a statement, and in reading the statements of anti-vaccinators he was astonished to find their literature made up of surprising misstatements, misquotations, and absurd descriptions of physiological subjects, and those who imbibed knowledge from these statements—and, generally speaking, they were the classes least able to judge—were the examples of the aphorism "a little knowledge is a dangerous thing," and suffered much evil from these misleading tracts.

Mr. Hart then went into a lengthy history of the ravages which small-pox had caused not only upon the British but other peoples of the world, and he remarked that if the like mortality occurred in England now to that which was constant in the olden time before the introduction of vaccination, the annual deaths from small-pox would be 70,000. Before the days of vaccination a third of all the deaths of children arose from small-pox, and all classes suffered from it. This was instanced from the fact that King William III. had his constitution broken from it, and lost, besides other members of his family, his wife, mother, and father from the loathsome disease.

The speaker quoted Macaulay's words lamenting that, while the plague had visited the country twice, the small-pox was constantly in our midst in olden time, cut-

ting off vast numbers of our people, and even when it spared the life of a child, it made it a changeling at the sight of which the mother shuddered. He then went minutely into each of the allegations of the anti-vaccinators and showed their fallacy, strengthening his case by quotations from the Registrar-General's statistics, from Mr. Simon's letter to the President of the General Board of Health, and from the evidence taken before the select committee of the House of Commons in 1871. In particular, he devoted much time to the allegations that vaccination had not diminished the mortality from small-pox, that it did not ward off an attack of small-pox in the individual, and that it caused increased mortality from other diseases.

He brought forward copious statistics to show the inaccuracy of these allegations, and showed on the contrary, from the accumulated facts of the last 80 years, how large an influence vaccination has in checking small-pox and in modifying its course in those vaccinated individuals who caught it. He gave figures to show that a thoroughly vaccinated person has only 1-70th of the chances of catching small-pox than an unvaccinated person has; and that if he be attacked by the disease, he has 50 times as many chances of recovery as a person unvaccinated. He explained the inaccuracy of the idea that vaccination inoculated other diseases, and pointed out that, as regards syphilis, the danger was infinitesimal, while on the other hand, there was the enormous assured advantage in vaccination of prevention

of mortality from small-pox. Mr. Hart insisted strongly on the necessity of vaccination being thoroughly performed, and of re-vaccination at puberty; and he made certain suggestions designed with a view to make vaccination more general and thorough. He summed up the evidence in favour of vaccination, which he described as overwhelming.

Statistics of Stammering

France.—M. Chervin, who has founded several institutions for the cure of stammering in European cities, and especially Paris, has published lately some curious statistics of this infirmity, and the conditions of its increase. A map of France indicating the degrees of prevalence of stammering shows 2 pretty distinct regions separated by a line from Bordeaux to Geneva. South of this line stammering is much more frequent than north of it. Paris has only 6 stammering recruits in 10,000, whereas the Bouches-du-Rhone has more than 153. The ordinary frequency, however, is about 5 in 1,000; at least at the recruiting age (for it seems to vary very much with age). Some of the Mediterranean departments, then, are extraordinarily subject to stammering.

M. Chervin also finds it frequent in Piedmont, which is under much the same climate and has a pretty similar population. He attributes this greater frequency, in part, to the extreme animation of speech of the Southerners, accompanied by gesture, demonstrations, and expressive mimicry, which some push even to grimace. The words (like a crowd issuing from a theatre)

come out in a jerking, irregular way, and impatience adds to the embarrassment. M. Bertillon has suggested (*La Nature*) that the various nervous maladies common in the south as a result of hot winds may affect some children with disorders which produce stammering. The most common cause of stammering generally, M. Chervin considers to be some sudden fright in childhood. A fire, a boat accident, or the like, will make a child a stammerer suddenly. The evil may, however, come gradually, and sometimes from involuntary imitation of stammering in another. It is curious that men are much more subject to stammering than women. All authors agree in this, reckoning only 10 to 20 females in 100 stammerers. Country parts contain twice or thrice as many stammerers as towns (according to recruiting data).

With this may, perhaps, be connected the other fact brought to light by M. Chervin, and which is easily explained—viz., that countries containing most schools have fewest stammerers. By learning to know their tongue, to distinguish, read, and write the different words, children must come to apprehend and articulate these more distinctly and avoid stammering. In savage countries, where grammar is an art wholly unknown, travellers have often been struck with the number of stammerers. M. Petitot mentions a tribe in North America, the Litchaureæ, of which all the members stammered more or less. To this frequency may probably be attributed the frequent re-

petition of the syllables in words of savages (as may be seen from any geographical map of Africa or America). M. Chervin shows that in France about 1,000 youths are exempted annually from military service because of stammering; and he considers the cure of the infirmity should receive more attention in normal schools.

Tunnel Trichinosis.—The Geneva correspondent of the *Times* writes under date March 15, 1880:—"The *Gazzetta Piemontese* gives some interesting particulars concerning the effects on the health of the men employed in the Gothard Tunnel of the unfavourable conditions in which they are compelled to work, with special reference to a disease engendered by the presence in the intestines of animalculæ having a certain resemblance to *trichine*. The general appearance of the Gothard miners, particularly of those of them—and they are the majority—affected by the malady in question, is described as deplorable in the extreme. Their faces are yellow, their features drawn, eyes half-closed, lips discoloured, the skin is humid, and the gait difficult. If they eat with appetite they cannot digest, and when wine is taken it is invariably rejected. Let a man be as strong as he may, 3 or 4 months' work in the tunnel seriously injures his health, and at the end of a year, or a little more, he is a confirmed invalid.

"Professors Calderini, of Parma, and Bozzolo and Pagliani, of Turin, have made several visits to Airolo for the purpose of studying the disease on the spot. They state that 70 to 80 per cent. of the men are suffering from this com-

plaint, to which they give the name of *anemia ankylostoma*, a term derived from the worm found in the intestines of a miner who died in the Turin Hospital last year. A somewhat similar malady, arising from the presence of the *ankylostoma* in the intestines, is endemic in Egypt and Brazil. Thirty per cent. of the cases are classified as 'severe,' and among the men who have wrought in the tunnel a year or more, 95 per cent. are affected. For boys from 14 to 16, many of whom, as I can personally testify, are employed in the tunnel, the Professors stigmatise it as 'a veritable hell,' continuous labour in its pestiferous atmosphere being almost certain death for the young.

"Professor Bozzolo is of opinion that 10 hours spent in the tunnel are sufficient to bring about a condition of body favourable to the development of *anemia ankylostoma*. The disease, though it has probably prevailed more or less for years, has only shown itself to an alarming extent during the last 6 months. Several causes have contributed to produce this result. The distance of the points of attack, as the extremities of the galleries where the perforators were at work have been called, from the respective entrances (on the north side, nearly 5 miles), rendered ventilation extremely difficult—an evil which was increased by the occasional freezing of the compressors. The air thus insufficiently renewed was further vitiated by the perpetual explosions of dynamite, of which the consumption has been at the rate of 660lb. a day, the

smoke from 400 to 500 oil lamps, and the exhalations from the bodies of 400 men and 40 horses. Add to this that a like number of men and horses have been working night and day in each section of the tunnel for years, that there is an entire absence of sanitary appliances, and that the temperature has averaged from 80 to 95 degrees Fahrenheit, and we have a state of things as inimical to life and health as can well be conceived.

"Of this, the mortality among the horses affords ample proof. They are kept in the tunnel only 8 hours out of the 24, yet they die—generally dropping down dead as if struck by a bullet—at the rate of 25 per cent. per month: that is, the average duration of equine life in the St. Gothard Tunnel has been exactly 4 months.

"As most of the miners employed in the tunnel are Piedmontese, the Italian professors, from whose report I have quoted some of the foregoing statements, naturally enough call the attention of their Government to the facts disclosed therein, and claim their interference on behalf of the men. It is only fair, however, to mention that the Swiss papers contest the accuracy of some of their conclusions, and, while admitting that the tunnel is by no means a pleasant place to work in, they affirm that things are not nearly so bad as Professors Bozzolo and Pagliani make out, and that the figures which these gentlemen give with reference to the prevalence of disease among the men require confirmation. Be that as it may, you could not pass 7 or 8

hours inside the tunnel, before the boring was completed, without suffering both at the time and afterwards considerable inconvenience, if not something worse, and on leaving it your feelings would not improbably resemble those of the Austrian journalist who, after a similar experience, telegraphed to his paper, 'I have been in the Gothard Tunnel, and I am glad to inform you I have come out alive.'

The Propagation of Diphtheria.—At a meeting of the Society of Medical Officers of Health at 1, Adam Street, Adelphi, on the 16th April, 1880, Mr. A. Wynter Blyth read a paper on "The Propagation and Prevention of Diphtheria." He remarked that this disease, scarlet fever, croup, erysipelas, quinsey, and puerperal fever formed a group which showed an inverse ratio with the number of rainy days at Greenwich, as well as an inverse ratio to the actual rainfall. The sanitary state of the localities or houses in which it arose seemed to have little bearing on its origin, seeing that it occurred in well-drained as well as in badly-drained dwellings. Diphtheria broke out in apparently the most haphazard manner, leaping unaccountably from spot to spot, and he considered that there was fairly strong evidence to accuse the atmosphere of being the bearer of contagion. The theory that it was due to the wafting of the poison by currents of air had been too quickly set aside on the authority of classical writers and Brettonneau.

Mr. Blyth in support of this thesis described a case which lately occurred at North Tawton.

A governess and child living in a house in the country perfectly isolated were simultaneously attacked the day after they had taken a walk together against a strong east wind. Their illnesses had all the characteristics of diphtheria, but there was no evidence of blood contamination, the temperature being only very slightly raised. Other cases were alluded to which had arisen at isolated houses, and these were mostly in lofty, breezy situations. In one village 5 cases broke out on high levels for 1 at the lower parts. An epidemic at Ilfracombe some years past was confined entirely to the loftier portions of the town.

After alluding to the doubts still existing whether diphtheria is transmitted by fungi, Mr. Blyth said that in view of these facts his theory was plausible, although not actually proven. All that it required was the communication of excessively small light particles evolved from the affected mucous surfaces. Fortunately by far the greater part of these fell on soil unsuitable for their development, and probably it was only when they fell on moist mucous surfaces that they can develop. Even when they did touch the larynx, in many cases, doubtless, they were unwittingly got rid of by swallowing, coughing, &c. In regard to the prevention of diphtheria it was said if it were assumed that the germ of the disease is essentially local first, and then constitutional, its ravages may be restricted by keeping the throats of the healthy who come in contact with the sick, constantly disinfected by means of disinfecting fluids. On the hy-

pothesis that the breathing discharges contain all the poison, this, combined with other obvious precautions, should restrict the malady to its first attack.

The question whether it can affect the same person twice cannot, in Mr. Blyth's opinion, be answered satisfactorily. Should it be caused by vegetable growth he would suppose the same person may be attacked an indefinite number of times.

Dr. A. Hill then read a paper on diphtheria and typhoid and their concomitant conditions in Birmingham. This related observations on the sanitary conditions of the houses in which these illnesses arose in Birmingham during 1 year. No deductions were made, but in regard to diphtheria it was stated that a majority of the cases were in dwellings below the mean level of the town.

In the discussion which followed various opinions were expressed as to the immediate cause of the disease. One gentleman pointed out that diphtheria was comparatively a modern complaint, and was not prevalent before drainage was carried out to the extent of recent times. Another officer of health stated that in his parish there was scarcely a case before the death of Princess Alice, but since then there had been a large number. In his opinion medical men were frequently in error when giving the causes of death, and there were fashions in the returns which they made.

Domestic Cisterns and Filters.

—At a recent meeting of the Health Section of the Social Science Association, Dr. Macadam of Edinburgh made some very pertinent observations on this question. He said that they had got into the system of lead cisterns, and he did not think they should easily get rid of them. Slate cisterns would, no doubt, be preferable. He did not approve of zinc cisterns for containing water for drinking or culinary purposes. As to earthenware cisterns, if they were glazed with common salt they would be safe, but if they were glazed with lead they would be prejudicial to health. Hard water might be rendered soft by Dr. Clarke's process of adding lime to it. He did not think it would be safe for any chemist to say that by any process of filtration or chemical treatment a contaminated and unwholesome water could be rendered safe. He was altogether opposed to filtration. Filters were sources of contamination. When a couple of gallons, say, of water were passed through a filter — be it charcoal, a sponge, or any other material — the intention was that all impurities should be left in the filtering material. This went on day by day, and in the course of a short time the suspended matter in the filter would be in a state of putrescence. People went on for years without paying any attention to the state of the filter, and the results could only be very serious.—*British Medical Journal*.

X.—THE WORLD OF INDUSTRY.

Hardened Glass.—M. de Luynes has recently communicated to the French Society of Encouragement, in the name of M. de la Bastie, further information on the progress which the industry in hardened or tempered glass has recently been making. He showed to the meeting numerous specimens, which presented the most varied and accurate forms. There were tubes for lamps, both gas and oil, goblets of various forms, mortars, and pestles, &c. As to the latter, M. de Luynes reminded the Society how frequently accidents happened with them; the least fall breaks them, whereas with hardened glass they stand any amount of hard usage. He also showed capsules for pharmacy and chemistry, of all sizes and shapes, plates of glass, crystal and enamel, coffee and tea cups in white enamel. He finished by making a striking experiment. Ordinary glasses were placed in a basket with drinking-glasses of the same shape in hardened glass; after several shakings, the ordinary glasses were all broken, while all the hardened glasses were intact. Thus it would seem that all the difficulties of the question have been solved.

But, what is more important, the processes of manufacture have been simplified and combined with the ordinary operations of glass-blowing, so as considerably

to diminish the expense and give more regular forms and more perfect execution. Objects made with the liquid material, when they are still red, are thrown directly into the tempering bath, and are not again heated to the melting point, as at first, which often causes a change in their form. Bottles, drinking-glasses, lamp-glasses, and other concave objects containing air are received on a curved tube, a sort of siphon, which at the moment of immersion allows the air to escape, while the liquid enters the cavity without difficulty. All these improvements have been adopted at the glass-works of Choisy-le-Roi, and it is confidently expected that in a very short time objects in hardened glass will be quite as cheap as those made in the ordinary way.

Austrian Petroleum Beds.—A considerable industry exists in the province of Galicia in the shape of petroleum wells, though its value is much depreciated by the difficulty of transportation, the nearest railway station being 30 miles distant. The petroleum field is some 400 miles long by 40 wide, extending from the north-west at Klenyzany to Remairi, in the south-east, and across the Carpathian Mountains to Jaslo. The most westerly of the districts in work produces about 400 barrels of oil per day, the wells varying from 500ft. to 800ft., and the oil

being refined on the spot. The other districts are very fluctuating in their yield. The Galician wells, however, produce a kind of wax called ozokerit, which is known to English housekeepers in connection with candles.

The White Wax Industry.—The white wax of Sze-chuen, China, is most peculiar in its growth. Baron Richthofen estimates the value of the annual crop, on the average, at about £650,000. In 1879 upwards of £81,000 worth of this curious entomological secretion was exported from the one port of Hankow alone. White wax is the mere exudation of an insect in a state of disease, aggravated probably by the operation of an uncongenial climate, and favoured by the presence of a tree for which the creature has an affinity. In the Keenchang district an evergreen, known as the *ligustrum lucidum*, thrives in abundance, and on its twigs in the spring of the year countless flies swarm like a brown film. The branches soon become covered with a white, soapy incrustation that increases in volume until the commencement of the fall of the year, when the sprays are cut off and immersed in water, which is kept boiling. The viscid substance rises to the surface, and is skimmed off, melted, and allowed to cool in deep pans. It was accidentally discovered that, by transporting the insects from their native district to the more vigorous one of Keating Fu, in the north of the province, their capability of discharging wax was largely augmented, a property that was promptly and extensively

made use of by the Sze-chuen traders. The period between morning and evening is chosen for conveyance, because many hours of sunlight would precipitate the hatching. This should take place only after the females have been attached to the trees. Arrived at their destination, 6 or more of the mothers—which are enormously prolific—are tied, wrapped in a palm leaf, to a member of the *ligustrum*. A few days later the young flies are swarming on the twigs, where they fulfil their mission by the month of August. Then they perish in the caldrons, where the results of their brief existence are collected. It is said that this peculiar industry requires the exercise of great care, forethought, and experience.—*Times*.

The "Damposcope."—Prof. Forbes, at a meeting of the Glasgow Philosophical Society on the 21st of January, 1880, described his instrument for detecting fire-damp and determining the quantity of light carburetted hydrogen in the air. It is called the "damposcope." The construction of it is very simple. Over the mouth of a straight brass tube is fixed a tuning-fork; inside this brass tube slides another tube of the same metal, which is moved by a regulating screw, so that the compound tube can be lengthened or shortened at will, and this movement is registered on a dial. To ascertain the amount of fire-damp in the pit, the instrument is taken to the suspected spot, the tuning-fork is set vibrating, and the screw turned until the maximum sound is emitted. The index is then read off, and it ap-

pears the quantity of gas can be determined to within one-half per cent.

The Dairy Industry in Holland.—The Danes have of late wrought a kind of revolution in the dairy industry, by adopting the following measures:—1. Complete change of the dairy year, which now commences on the 1st of November, and terminates on the 31st of August. In this way the Scandinavian farmers produce the maximum of butter at a time when the prices are very high; while the butters of other countries come into the London market during the spring and summer, the butters from the North hold a place during the whole of winter, and have a remunerative sale. 2. Introduction of the Swartz system into the dairies; that is, cooling of the milk in ice after milking, creaming after 12 hours, exact regulation of churning, kneading, and other manipulations, substitution of long and cylindrical tin vessels for the small shallow tubs of wood. Also daily churning. 3. Manufacture of *siedmaer*, or butter churned immediately after creaming; this product, which has not immediately either aroma or taste, is destined for exportation to distant countries, Brazil, China, Japan, the Indies, &c.

Japanese Railways.—The railway system is extending rapidly in Japan, 2 lines having been recently completed in the island of Nippon, and a third in the island of Yesso, the most northerly of the Japanese group. The rails are of English make, but the rolling stock and engines have been ordered in America, the for-

mer being supplied with Westinghouse brakes, and the latter with spark arresters, a very proper precaution on the part of the Japanese authorities; for were a chance spark to light upon one of the shingle roofs by the side of the railway, whole villages would be swept away and a very natural feeling of hostility be developed towards railway enterprise. The two first engines are to be named Benkei and Yoshitsze, after two celebrated early Japanese heroes. It is the first order of the kind that has been given by Japan to American houses.

The Manufacture of Dynamite.—The industrial production of nitro-glycerine, the base of dynamite, has been attended with no little danger, as many terrible accidents bear witness. Among the prizes recently awarded by the French Academy of Sciences is one of 2,500f. to MM. Boutmy and Foucher, who, by introducing new modes of producing nitro-glycerine in large quantity, and by various precautions, have rendered the manufacture of dynamite much safer, so that in their works at Vonges no life has been lost during the last 6 years, and the general health has been excellent. In the old method, in which fuming nitric acid, or a mixture of this and sulphuric acid, is made to act on glycerine, and the mass is suddenly immersed in water, the reaction often produced heat sufficient to decompose a part of the nitro-glycerine, occasioning violent explosions (in spite of the refrigerating processes adopted).

The principle of the new process consists in obviating the greater

part of the heat by first engaging the glycerine in a combination with sulphuric acid, forming sulphoglyceric acid, and then destroying slowly, by means of nitric acid, the sulphoglyceric compound. Two liquors are prepared in advance—a sulphoglyceric and a sulpho-nitric (the latter with equal weights of sulphuric and nitric acid). These disengage a considerable amount of heat; they are allowed to cool, and are then combined in such proportions that the reaction takes place slowly. In the old method the nitro-glycerine is separated almost instantaneously and rises in part to the surface, rendering washing difficult. In the new it forms in about 20 hours, and with a regularity which prevents danger. It also goes to the bottom of the vessel, and can be washed rapidly.

Destruction of Fire-Damp.—A mining student of Freiberg has invented an improved lamp for the protection of life against explosions of fire-damp. It is based upon the property possessed by ethiops of platinum of condensing on its surface not only oxygen, but also light carburetted hydrogen even when only small quantities of it exist in the atmosphere, and in this close contact of the 2 gases effecting a dark combustion of the carburetted hydrogen. A wire-gauze lamp is charged with pieces of pumice stone, impregnated with ethiops of platinum. These lumps are surrounded by coke to protect them, and enclosed in the lamp, which is then ready. In the presence of fire-damp the ethiops of platinum attracts the gas, which is gradually and harmlessly destroyed, the consumption

being within the gauze and not of a nature to ignite a surrounding explosive atmosphere. Mr. Körner, the inventor, points out that a great advantage of this safety, inflammable, air-consuming lamp, consists in its not requiring continuous attention and maintenance, as the ethiops of platinum will consume a large quantity of the light carburetted hydrogen without losing its properties. Control of the lamp is effected through the escaping heat. Lamps as described may be advantageously used in all places where there is inflammable air.—*Mining Journal.*

The Greening of Preserved Vegetables.—It is known that the green colour given to preserved vegetables is generally obtained by means of the salts of copper, the presence of which in preserves is both dangerous and fraudulent. M. Lecourt, a preserve manufacturer of Paris, and Professor Guillemarie, of the Lycée of Rheims, have devised a new process for such colouration, which is the subject of an interesting report addressed to the Consultative Committee of Public Hygiène of France by MM. Wurtz, Gavarre, and Bussy. This new process consists in adding to the vegetables employed a surcharge of chlorophyll, so that after the inevitable loss caused by boiling at 120 deg. Cent., they still retain sufficient to present the green colour of fresh vegetables. MM. Lecourt and Guillemarie obtain the green colour thus utilised from table vegetables, especially spinach, which contains a great quantity that is easily extracted. By an appropriate manipulation

they obtain this green matter in solution in water alkalized by soda.

The application of the colour is made thus: the vegetables being plunged in boiling water, previously acidulated by chlorohydric acid, a suitable quantity of the solution of chlorophyll is turned into the water; by saturation of the soda, by means of chlorohydric acid, sea salt is produced, and the colouring matter is deposited in the organic tissue to increase the intensity of its proper colour. The vegetables thus treated are submitted to several washings before being enclosed in the vessels in which they are to be submitted to the high temperature necessary for their conservation.

Statistics of the Production of Beer.—Some official tables connected with the production of beer in all the European countries and the United States have been lately issued under the authority of the Austrian Government. The following is the production during 1879:—The whole German Empire produced 38,946,510 hectolitres, or 23,811,117 British barrels; Great Britain, 36,597,550 heccts., or 22,375,010 barrels; the United States North America, 15,400,000 heccts., or 9,425,252 barrels; Austro-Hungary, 11,184,681 heccts., or 6,838,090 barrels; France, 8,721,000 heccts., or 5,331,845 brls.; Belgium, 7,854,000 heccts., or 4,801,778 barrels; Russia, 2,300,000 heccts., or 1,406,174 bls.; the Netherlands, 1,600,000 heccts., or 978,208 barrels; Denmark, 1,100,000 heccts., or 672,518 bls.; Sweden, 930,000 heccts., or 568,583 barrels; Italy, 870,000 heccts., or 531,000 barrels; Switzerland,

724,000 heccts., or 448,753 barrels; Norway, 615,000 heccts., or 376,000 barrels. The greatest production in proportion to the population is in Belgium, where 167 litres, or a little over 34½ gallons per head, were manufactured; and the smallest proportion was in Russia, where the ratio is only 3 litres, or a little more than 5½ pints for every inhabitant.

The Steel Trade of the World.—The total capacity of the steel mills at the present time throughout the world is estimated at about 3,000,000 tons for the year's production. In the United Kingdom there are 120 Bessemer converters built, of which over 80 are at work, and the annual yield from these is considered as from 755,000 to 800,000 tons. The American make is estimated at 750,000 tons, the next largest producer being Germany, which is considered by many to be capable of the greatest expansion among the steel-making countries. Less than two years ago there were 25 converters in Prussia working out of the 50 built, and turning out 375,000 tons, which were increased by the works in Saxony and the Palatinate to 400,000; and since the revival of trade fresh converters have been put into operation. The estimate of the French steel manufacture is about 275,000 tons; that of Belgium, 150,000; of Austria, with 32 converters, 250,000; and of Sweden and Russia, 150,000. Of the Bessemer converters in England, the largest are two 10-ton ones at Sir John Brown and Co.'s works, in Sheffield, the others varying between three and eight tons in capacity; and out

of the 25 British steel works, only 17 have rail mills.

Chinese Steel.—A considerable steel-making industry exists in the present day in China, on the Upper Yangtze, whence the steel is sent to Tient-sin for shipment and distribution. It fetches much higher prices than the Swedish steel imported into the country. The Chinese metallurgists recognize three kinds of steel—namely, that which is produced by adding unwrought to wrought iron while the mass is subject to the action of fire; pure iron many times subjected to fire; and native steel, which is produced in the southwest. The different names for steel are twang kang, or ball steel, from its rounded form; kwan

g, or sprinkled steel; wei tec, or false steel. The Chinese, apparently, have known how to manufacture steel from the very earliest ages, and in the time of the Hau dynasty ironmasters were appointed in several districts of the old Leangchou to superintend the iron works.

Stereotype Plates.—M. Emile Jeannin, of Paris, proposes to use celluloid for the process of obtaining stereotype plates for printing. The remarkable properties of this preparation appear to fit it in a peculiar manner for stereotyping, especially for cylinder machines running at high speed. A celluloid plate will yield, it is stated, 50,000 impressions.

Japanese Mines and Mining.—In the second volume of the "Memoirs of the Science Department of the University of Tokio, Japan," Professor Netto gives a very interesting account of the mineral resources of that country.

When Japan was thrown open for intercourse with the outer world the belief was general that the mineral treasures of the country would in a prominent degree become the subject of commercial enterprise. Marco Polo and Kaempfer had spoken of its inexhaustible wealth in gold. The Dutch and Portuguese, despite the limited nature of their intercourse with the natives, had managed to export bullion estimated at over 500 millions of dollars between 1550 and 1671. It was known that gold was only of six times as much worth as silver, and people thought this indicated rather a superfluity of gold, instead of, as the fact was, a relative scarcity of silver. Copper, too, after the opening of the country, had been exported in large quantities, enticing one into an overestimate of the country's powers of production; whereas in reality the Japanese had only thrown on the market a quantity of manufactured metal in the shape of old gate mountings, idols, temple ornaments, and either directly or after having re-melted them. In the course of a few years the truth as to the country's mineral resources came out, and Japan was found not to be a second Eldorado. Gold and silver were there, but neither could be obtained without a very considerable amount of labour. Copper mines abounded; some of the mountains were literally honeycombed with old workings and explorations; but the Japanese had much more thoroughly searched the soil than had been anticipated.

If formerly the hopes of wealth had been over-sanguine, now

there was a reaction in the opposite direction, and a bias set in to entertain most pessimistic views in respect of the future of mining in Japan. In Professor Netto's memoir the whole subject is reviewed candidly and at length, and he comes to the conclusion that Japan will never realize the former sanguine dreams in regard to its production of the precious metals; that, as regards lead, tin, quicksilver, cobalt, and petroleum, the produce will never reach any considerable figure; but that as regards copper and coal they have before them a probably great future, the realization of which will in great measure depend on the mines being worked on a modern system. The present methods of working are described in the memoir, with illustrations. The value of the total produce of the mines in Japan for 1877 is given at £850,000, of which the value of the coal was £312,498; of the copper, £287,212; of the silver, £90,212; and the remainder value was that of the gold, iron, and petroleum.

Malleable Bronze.—M. Dronier has patented in Germany a process for rendering bronze as malleable as copper. About 1 per cent. of mercury is added to the tin in a warm state, and this is then mixed with melted copper.

Coffee Production of the World.—The four great coffee countries of the world are Brazil, Java, Sumatra, and Ceylon. The data and figures for 1879 show that Brazil itself has produced an extraordinary quantity of beans. Hitherto 250,000 tons have been considered as a good yearly figure for Brazil;

ed to 273,000 tons. But the consumption of coffee in the country itself now amounts to 60,000 tons, raising the total yearly product of Brazil to 333,000 tons. Fortunately for the planters in other parts of the world, coffee has grown into a necessity in the United States, and, thanks to this, its price has risen. Although the soil of Brazil, especially for coffee culture, is very extensive, yet the difficulty of obtaining labour daily becomes greater, and this renders it doubtful whether the above figure can be much exceeded. The crop in Java and Sumatra was estimated at 94,000 tons for export; the consumption of the inhabitants, although the population is double that of Brazil, is not half of that of the latter country. The production in Ceylon, though greater than that of 1878, shows a falling off when compared with former years; there were in all 41,200 tons exported from the island, the native consumption being very small.

Coffee is, besides, grown in Central America, in several of the South American republics, in the British and other colonies of the West Indies, in Hayti, Cuba, Porto Rico, Arabia, Mauritius, Réunion, and along the north-east coast of Africa, in Liberia and the African West Coast, in Manilla, Celebes, and several of the islands of the Pacific, and, lastly, in British India. But the total production of all these regions does not reach half of the export of the four chief countries named above.

A New Fibre.—In the Paris

Exhibition was shown a sample of fibre named *Malachra rotundifolia*, sent from Bombay. This plant is, however, only found in South America—at least so says

Dr. King, to whom the supposed *Malachra rotundifolia* was sent for identification, and he states that it is *Malachra capitata*, not *Malachra rotundifolia*. As a fibre, be it what it may, it undoubtedly deserves attention, for it is said to be quite equal to jute. The following is the description given of it:—"The fibre is in length from 8ft. to 9ft., has a silvery appearance, with a peculiar lustre, and is almost as soft as silk. In passing the fibre through the machinery damped with oil and water, as is commonly done with Bengal and Konkan jute, yarn was produced strong enough and nearly equal to that made from the second quality of Bengal jute. If the plant is carefully grown and well looked after, the fibre would then no doubt rank fully equal to Bengal and Bombay jute. Owing to the high prices ruling for jute in Bengal and elsewhere, the new fibre, if carefully prepared, would command a ready sale at 3·12 rupees to 4 rupees per Indian maund. There appears to be no difficulty in growing this plant, which belongs to the natural order of *Malvaceæ*, in Bengal, marshy places within the tropics being considered favourable to its growth, and there is, therefore, every reason why a fair trial should be made of its apparently valuable properties. The

fibre is prepared in precisely the same way as jute, but requires to be steeped directly it is cut, as exposure to the sun dries and

hardens the stems, preventing the easy removal of the bark from them, and rendering the fibre itself coarser in quality than it would otherwise be."

Oxydized Iron.—To most of our readers the appearance of oxydized silver is doubtless well-known, while all must be familiar with that of oxydized iron. Although widely differing in appearance, the two metals, under the circumstances stated, are in a precisely analogous physical condition, both being simply in a state of rust. One of them, however—silver—can be made to present an attractive and even artistic appearance; while the other—iron—is more or less repulsive, and is suggestive of anything but artistic beauty, being the embodiment of decomposition and decay. We are, of course, referring to iron in a state of rust or oxydation produced under ordinary circumstances, such as exposure to moisture or atmospheric influences. The metal in such case becomes coated with what is known as a hydrated sesqui-oxide, the bright red appearance of which is well known. But there is another kind of oxydation in which the metal is coated with what is known as a magnetic oxide, when its leading physical conditions are entirely reversed. In appearance it can be made very attractive, if not elegant; while instead of being in a state of change and decay, its condition, so far as its surface is concerned, is that of permanent preservation.

There are two processes by means of which this protective coating can be produced on the surface of iron, although it is only

by one of these that an ornamental and artistic appearance can be imparted to the objects treated. In other words, one of these processes succeeds in so oxidizing iron as to render it more useful than in its ordinary condition, while the other renders it not only more useful, but much more ornamental. These two processes owe their results, the first to the action of water, and the second to that of air upon the metal. The water process is that which has become identified with the name of Professor Barff, whose happy idea of applying in practice the well-known principle of exposing iron to the action of super-heated steam, whereby it acquires a tenaciously adherent coating of magnetic oxide, is already well known. This process most effectually protects the surface of the metal from becoming rusted, the iron after treatment assuming a dark-grayish, glazed appearance. The process has been for long past in practical working in a variety of useful directions, and with every success.

The practical development of the second, or air process, is due to Mr. George Bower, C.E., of St. Neots, Hunts, who, it would seem, only by a mere chance missed winning for himself the credit which has attached to Professor Barff in the matter of the water process. It appears that some 12 or 14 years since Mr. Bower was making some experiments in connection with the decomposition of water, by passing steam through red-hot iron in a retort, when he found that at first the iron decomposed the water rapidly, but that it gradually became less active, and finally ceased to produce any effect whatever. Upon examining the iron it was found to be coated with a kind of enamel, which at once suggested the idea of the application of the principle to the protection of iron surfaces. On exposing the enamelled iron to the atmosphere, however, the coating separated from the body of the metal, and Mr. Bower did not pursue the matter any further. The untoward result was doubtless due to the fact that the iron operated upon was old and rusty; had it been new, the probability is that Mr. Bower would have been the first to introduce into practice the system of coating iron by magnetic oxide, produced by the action of aqueous vapour on the red-hot metal. It, however, subsequently occurred to Mr. Bower that what Professor Barff was accomplishing with water he might be able to do with air, and he therefore commenced a series of experiments in the latter direction, which resulted in success. What he did was to make the articles to be protected red-hot in a chamber heated externally. When they had reached the proper temperature a few cubic feet of ordinary atmospheric air were blown into the chamber, which was closed, and the iron then entered into combination with the oxygen of the air, a thin film of magnetic oxide being formed on the metal. The operation of blowing in air was repeated as frequently as was necessary to produce the desired thickness of coating, which depended upon the nature of the articles being operated upon. This was the simple air process.

In practice, however, considerable difficulty was experienced in heating the chamber and the articles in it by the external application of heat, and the working of the air system was, moreover, attended by great wear and tear. It then occurred to Mr. A. S. Bower, who was assisting his father in developing the process, that it would be a great step in advance if the iron articles could be heated, and the coating of magnetic oxide at the same time be produced, by the combustion of gaseous fuel inside the chamber. Another series of experiments was, therefore, undertaken, and in the end the desired results were fully attained by means of the apparatus in which the process is now carried out on a commercial scale, and which we recently witnessed in operation at Mr. Bower's works, at St. Neots. This apparatus consists, in the first place, of a set of three small gas furnaces, for the production of carbonic oxide. These are constructed by the side of a chamber sufficiently capacious to contain about a ton of miscellaneous articles, such as umbrella-stands, gas-brackets, saucepans, ornamental iron castings, and the like, which constituted the charge on the occasion of our visit. Beneath the chamber is a series of pipes, in which, before entering the chamber, the air is heated by means of the waste heat from the furnace. The process conducted in this apparatus, and which is a marked improvement upon Mr. Bower's simple air process, consists in alternately oxydizing and deoxydizing the iron. The articles are heated by burning the gaseous fuel inside the closed

chamber. Heated air, in excess of the quantity necessary for the perfect combustion of the gas, is made to enter along with the fuel, and this, together with the product of combustion (carbonic acid gas) produces next the metal magnetic oxide, and on the top of it a film of sesqui-oxide, which is reduced to magnetic oxide by shutting off the supply of air and applying for a short time carbonic oxide only. The time required for the treatment of a charge varies from six to ten hours, and on withdrawing the articles they are found to be covered with a protective coating of magnetic oxide, which renders them proof against atmospheric influences and the action of moisture.

Were the results of the process to stop here it might be sufficient, but protection from rust is not all that is effected; the process accomplishes yet more, inasmuch as for decorative purposes it obviates the necessity for painting the iron. It gives a new appearance to the articles, which on leaving the heating chamber assume a beautiful French-gray tint, which, like the coating, is permanent. This is an additional advantage in Mr. Bower's process. Should, however, the colour thus imparted not be suitable from an artistic point of view, the iron can, of course, be painted, and with the certainty that no rust can ever form underneath the paint to throw it off as in the case of ordinary iron. The question of economy, too, appears to be satisfactorily answered, as it is stated from practical experience of the working of the process on a commercial scale that the absolute net cost of the coating of

magnetic oxide is much less than the cost of a coat of paint. With respect to the protection afforded to the metal by this process we may observe that the oxide thus formed has been tested very critically, and is found to withstand all ordinary atmospheric conditions perfectly. It appears to be thoroughly incorporated with the metal, as indeed it must be, for it is the union of the iron with oxygen which forms the coating. A

of ironfounders in Glasgow have successfully put the process to a severe proof both by fire and water, while Mr. F. J. Evans, the late engineer of the Chartered Gas Company, and Mr. Joseph Kincaid, C.E., both speak approvingly of the process after having tested for a lengthened period articles coated by it. It is something to know that if there is the bane there is also the antidote, for both wrought and cast iron, no matter how rusty, may be treated by the carbonic oxide process and have the rust converted into that which will protect the metal from further rust. It is gratifying to find that the efforts of Mr. Bower and his son have been crowned with success, and we congratulate them on the unique results of their process, which cannot fail to prove of great advantage as well from an economic as from a decorative point of view.—*Times*

Agricultural Education.—In the Chemical section of the British Association, Mr. J. M. Cameron, of London, read a paper on "The Position of Agricultural Education in this country, as compared with that on the Continent of Europe." The writer pointed out, in the first place, the import-

ant influence which chemical research had had on manufactures, and regretted the apathy shown by the agricultural population in seizing upon and applying chemical researches bearing upon agriculture. Were it otherwise, he was sanguine enough to say that there would be less depression, and that protection would not be so often pointed to as the haven of refuge for what he believed to be largely due to ignorance and incapacity.

In face of the indifference of the farmers, however, chemists were pursuing research. In Great Britain there were, he calculated, 255 Farmers' Societies; but these, with the exception of the Royal Society, and the Highland and Agricultural Society of Scotland, had done nothing for our agricultural education, and our farmers could not tell the difference between soluble and insoluble phosphate, or between nitrate of soda and ammonia; nor could they give an intelligent opinion as to the origin and composition of the soil which they tilled. The position which the landed proprietors had taken up was a very unsatisfactory one. One would have expected that they would have identified themselves with the subject much more closely than they had done, and they had not sufficiently recognized the duties which are, in common with rights, attached to property.

The facilities for acquiring a knowledge of scientific agriculture in this country were exceedingly meagre. In England there were only 3 institutions for such a purpose (2 of which were new), in Scotland there were 2, and in Ire-

land there were some 340; whilst in Germany there were 1,305. In England, the subsidies granted by the Government in this matter amounted to 100th part of a farthing per head of the population; in Scotland, to one-tenth part of a farthing, and in Ireland, to two-fifths; whereas, in Holland, they reached to one halfpenny and three-fifths of a farthing.

With respect to agricultural research, Mr. Cameron spoke highly of the work done by Messrs. Lawes and Gilbert, at Rothamsted, and mentioned that the Royal Society had established an experimental station at Woburn; that the Scottish Society had done a similar thing; that the Royal Agricultural Society had formed a Committee for the purpose of establishing experimental stations, and that he himself had established such stations in Kent, Sussex, and Scotland. The Aberdeenshire Agricultural Society had also taken action. The latter portion of the paper was devoted to a variety of suggestions.

Mr. Cameron proposed, amongst other things, that in every elementary school there should be taught to children, in the last year of compulsory attendance, the first principles of agriculture: that a teacher should not be considered qualified unless he had the Agricultural certificate of the Science and Art Department; and there should be, in each parish, at least one central school, in which instruction in agriculture should be given, and connected with which there should be an experimental station, and that committees of farmers should be established to arrange for lectures.

A New Discovery in Butter-Making.—Dairying is the one branch of agricultural industry which, by common consent, is to be a mainstay of British farmers against foreign competition. New apparatus, new processes, new systems are being introduced in the cream-raising, butter-making, and cheese-making of our dairies; and where novel methods are not deemed indispensable, attention of a new and important kind—namely, that of the master of the farm—is being devoted to the more perfect carrying out of the methods now in use. It has been found out that English dairymaids need to be instructed especially in the art of making butter. They do not always churn sweet cream; they do not churn at the right temperature; they do not stop the action of the churn at that particular point when the butter has just come in little nuggets like rough marbles; they do not withdraw the buttermilk and then wash the butter in the churn with repeated doses of salt water, until the water runs out clear; they do not refrain from mixing in powdered salt after this; and they do not work out every drop of buttermilk by fluted wood roller, instead of squeezing and rubbing the butter by hand. The improved practice is being extended, and so awakened are the public becoming to the importance of keeping at home the many millions of money now spent in foreign dairy produce, that even gentlemen by no means dependent upon farming are starting herds of dairy cows. You hear of baronets and men of lesser note building cow-houses at their

country seats, and entering upon the milk trade with their 50, 100, or 150 milch cows.

Now, a discovery has been lately made which brings a new element into the calculation of the future of the trade in butter. On the 24th July, 1879, Mr. G. M. Allender put a churning of butter to the test, treating it in accordance with a new patent brought before him. The butter, in a muslin cloth, was placed in a firkin, without a particle of salt, and every precaution taken to ensure that there could be no tampering with the experiment. The firkin remained on the premises at St. Petersburg Place, Bayswater, for three months, and when examined, on October 24, it was as sound and sweet as when first put in. Practically this butter was exposed to the atmosphere during the whole time, seeing that air found free admittance into the firkin. Without treatment the butter would have gone completely putrid; but on smelling and tasting it, we found it perfectly sweet, firm, and so excellent in flavour that we could not tell it from butter made the day before. Experts in the business, both in this country and in Ireland, have had samples, and pronounce the preservation wonderful; the only difference they find being that newly-made butter (and this first-rate of its kind) has a peculiar aroma not quite equalled in the preserved butter; while the latter is considered a little "dead," so that just a trace of salt in it would be an improvement.

The effect will be to drive all salt butter out of the market. In

order to make it keep, the Irish and all imported butter is now mixed with 5 or 6 per cent. of salt. Under the new system 1 per cent. of salt will be ample for the purpose, and the cost of the preservative will not exceed half a crown for a 56lb. firkin, or little more than a halfpenny per pound. The difference in value between a very mildly-salted and a coarse and strongly-pickled butter is at least 4d. per pound, and hence it appears possible that fortunes may be made by substituting preserved for salted butter, alike in the immense quantity shipped from Ireland and in that brought from foreign countries. It is not possible to estimate the gain of being able to displace from our tables and from our cookeries the objectionable salt butter, the change being especially grateful to voyagers on ship-board and to countries such as Brazil, which import the whole of their butter.

One great feature in the trade in future will be the purchase and storage of butter in summer, when prices are low, for sale in winter, when prices rule higher—with considerable effect towards equalizing the two seasoned prices to consumers. Preserved butter, of course, will not be able to compete with the choicest new-made butter; but, nevertheless, the result of displacing salted butter must be immense. The great merit of the invention consists in its simplicity. The butter, worked with a trifling quantity of the patent material (alleged to be perfectly harmless) directly after churning, keeps good and sweet for months without any particular care bestowed upon its situation or tem-

perature, except that, like other butter, it has to be kept in a moderately cool place.

Probably this new odourless, tasteless, and innocuous antiseptic may work other wonders with meat, fish, and like perishable food commodities.

Our Progress in Ten Years.—Nations should not only take a decennial census of population, but also draw up a balance-sheet every ten years of what progress they may have made in industry, wealth, commerce, instruction, and morality. We have only to compare the returns of the Board of Trade for 1879-80 with those of 10 years ago to see the advancement of the United Kingdom, as follows :—Increase.—Population, 11 per cent.; revenue, 8 per cent.; public wealth, 30 per cent.; commerce, 13 per cent.; shipping, 16 per cent.; textile manufactures, 29 per cent.; minerals, 45 per cent.; railway traffic, 45 per cent.; post office, 45 per cent.; schools, 122 per cent.; public morality, 12 per cent.; welfare of poor, 19 per cent. Population has not grown so fast as in previous decades, but the ratio of increase is still much higher than the European average. It was 13 per cent. in England and 10 in Scotland, while Ireland showed a decline of 1 per cent., owing to emigration. The total number of British emigrants was 1,654,000, from which, deducting those who returned, the balance or net loss would be 875,000, and if these were added to the actual population the increase would reach 14 per cent. Revenue or taxation is lighter now than it was 10 years ago, the average for last year being 48s. per in-

habitant. In the same interval the National Debt has been reduced by 24 millions sterling. Public wealth is pretty accurately measured by the income-tax valuation, which is now £134,000,000 higher than in 1869, an increase of £4 per inhabitant; even in Ireland the ratio is higher by £2 per head. It seems that the average income varies in the three kingdoms as follows:—£19 in England, £15 in Scotland, £7 in Ireland, and £17 for the whole United Kingdom. The accumulation of wealth among the working classes, as represented by deposits in savings banks, has risen from 51 to 76 millions sterling, being almost 50 per cent. Compared with population, the savings deposited since 1869 have been 18s. per inhabitant in England, the same in Scotland, and 4s. in Ireland. It is, furthermore, worthy of observation that the deposits in the Bank of England reached 39½ millions sterling in 1879 against 22 millions in 1869, the increase being relatively almost double as great as in the savings banks.

Commerce has likewise grown faster than population, showing last year a ratio of £17 18s. 3d. per inhabitant against £17 4s. 6d. in 1869. Many people erroneously suppose that it is only our imports that increase, while our exports decline. Suffice it to say that the exports of 1879 were 12 millions sterling over those of 1869, being an increase of 5 per cent. Our merchant shipping (not including colonial) has risen 860,000 tons, but the effective carrying power is almost doubled, owing to the enormous develop-

ment of steam traffic. In 1869 steamers were 17 per cent. of our shipping, the present ratio being 38 per cent., and, if we count them as four times the power of sailing vessels, we find our carrying power is now 14 million tons, as against 8½ million tons ten years ago. If we include colonial, the total British tonnage would be equivalent to 19½ million tons, the total for all nations being a little over 40 millions. Manufactures, minerals, and railway returns show at a glance the progress of internal industry. Our mills in 1879 consumed 1,615 million pounds of cotton and wool, against 1,248 millions in 1869, an increase of 29 per cent.; while our mining industry rose 45 per cent., the value of coal, iron, &c., extracted last year amounting to 64 millions, against 44 millions in 1869. By a remarkable coincidence, our railway traffic has grown in the same ratio as minerals, the gross earnings having risen from £11,100,000 to £59,400,000. Another coincidence is the post office increase, also 45 per cent.—viz., 847 million letters in 1869, and 1,239 millions last year.

All the above items show material progress, and if we turn to the indications of moral improvement we find the figures no less satisfactory. The number of criminals convicted in the three kingdoms has declined from 14,340 to 12,523—a fall of 13 per cent., and it may therefore be said that public morality has advanced in the same degree. School statistics show that the average attendance in Great Britain has risen from 1,333,000 to 2,980,000 children,

the increase being 11 times greater than that of population. Finally, we may gauge the condition of the poor by the number of paupers relieved; and as this has fallen from 1,281,000 to 1,037,000, it follows that there is an improvement equal to 19 per cent.

There is but one branch of national wealth or industry that shows a decline—viz., agriculture, the area under corn and green crops having fallen in ten years from 17,096,000 to 15,610,000 acres, a decline of 8 per cent. for the United Kingdom, although the figures for Ireland show that the falling-off in that country was as much as 16 per cent. It may be questioned, however, whether the rural products of the United Kingdom have at all declined in the last ten years, seeing the increase in the number of cattle—viz., 8 per cent. in cows, 12 per cent. in horses, 6 per cent. in pigs; the only set-off being a loss of 6 per cent. in sheep. Even in Ireland (counting ten sheep for one head of cattle) we find the farming stock increased 8 per cent. Thus the growth of pastoral interests has in all reasonable probability compensated the loss in tillage.

Summing up the condition of the United Kingdom at present, as compared with ten years ago, we have every reason to be proud of the progress we have made. It is manifest that we have grown in prosperity much more than in population, and that every succeeding decade, in spite of an occasional crisis or reverse, sees Great Britain richer, wiser, and happier, thanks to the industry and civic virtues of her people.—*Times*.

XI.—MISCELLANEOUS.

A Curious Monopoly in Japan.—It seems that in the midst of a general conflagration a Japanese householder can only insure immunity for his property by promptly offering a sufficient bribe to the firemen. When this is done, the latter are perfectly reckless as to the destruction of other property in carrying out their contract. "Here is a vast city," says the *Tokio Times*, "containing a million of inhabitants, all peculiarly exposed to the extremest hazards of fire, and without a solitary steam machine in use or existence—with hardly an efficient land engine at command. It is an historical fact that during a conflagration in 1873 a steam engine, brought to Japan on speculation, was put in operation with a success that showed how easily a dozen such could keep the city permanently free from peril. In less than a week after the triumph upon which he had been vainly congratulating himself, the exhibitor found it desirable to leave the capital with his machine, which was straight-way re-shipped to America. The experiment has never been repeated, and why? Because the firemen will not allow it. There is no other answer, and none is offered. Until the firemen of Tokio are disbanded, their organisation broken, and their leaders rendered incapable of further conspiracies against the security of the country at large, no genuine protection will be possible."

Oil on the Troubled Waters.—Prof. Osborne Reynolds, at the meeting of the British Association, exhibited some experiments to illustrate the effects of oil in calming troubled waters, and therefrom drew some conclusions as to the theory of waves. There are many recorded instances of the effect of oil in preventing the waves of the sea from breaking over a labouring ship, but we believe this is the first time the subject has been taken up by the scientist.

A new form of Thermoscope.—The *Scientific American* describes a new form of thermometer or thermoscope which depends for its action upon the variations of tint undergone by a solution of chloride of cobalt in alcohol, according to the temperature of the surrounding air. Artificial rosebuds for denoting change of weather by alteration of tint have for some time been sold in London, and they doubtless owe their power to the same agency. Mr. Woodbury, of photographic celebrity, some time ago published the details of a very pretty experiment with the same salt. He coats a piece of glass with the solution, to which has been added a small proportion of gelatine. This is dried, and is introduced into a magic lantern, together with an ordinary photographic transparency. At

first the resulting picture appears upon the screen as if illuminated by a rosy sunset, but as the material warms it changes to a bright blue. In the thermoscope in question the solution of cobalt is contained in an hermetically sealed glass tube, and a kind of colour scale is attached with which its readings can be readily compared.

Under the Channel to France.
—M. Ernest Denedict, at the meeting of the British Association, made a new suggestion as to a Channel tunnel to France. He gave an elaborate account of the engineering operations requisite for its construction, which would require an outlay of £6,000,000, probably increased to £8,000,000, by the cost of apparatus, &c. That sum would require £500,000 a year to pay 5 per cent., or 27 trains in each direction, at an average profit of £1 per train per mile; and that would be less than a third of the total number of trains that could be worked through the tube daily. The increased traffic on the connected railways on each side of the Channel would be great, and it would pay those railways to subscribe the capital required. That being the commercial aspect of the enterprise, it was important to consider that the undertaking would be of great national importance. There was not a country in the world except England which could turn out the materials within any reasonable period. It would stimulate trade during construction, and after its completion would result in a permanently increased development of traffic in many articles of commerce. The pecu-

liarity of this scheme was that, instead of tunnelling through doubtful geological strata, which might have faults like those met with at the tunnel under the Severn, near Bristol, it was proposed to carry across the Channel a tube 16ft. in diameter, at 35ft. below the lowest water level.

Mica among the North American Indians.—At a meeting of the Philadelphia Numismatic and Antiquarian Society in December, 1879, Dr. D. G. Brinton made an important communication on the subject of the Aboriginal Mica Mines of North Carolina. In laying before the society specimens of the implements used by the aborigines in working the mica mines of North Carolina, Dr. Brinton briefly referred to the use of this substance by the North American Indians. It was evidently highly esteemed among them as an article of adornment, and in the opinion of the learned archaeologist, Professor Rau, was even invested with a mysterious significance in their superstitious rites. In the mounds of Ohio it has been discovered in large quantities, sometimes 15 to 20 bushels in a single mound, which is the more remarkable as it is found nowhere in that State in natural deposits. All of it was brought from a distance, probably from the aboriginal mines of North Carolina. The mica plates were used to cover the bones of the corpse after the fire had charred the remains, as a sort of pavement round the sacrificial altar, and as decorations which the dead might find of use in their spiritual homes. To suit the latter purposes, the mica was cut into circular, oval,

or diamond-shaped patterns, with extraordinary precision and neatness, and pierced with a hole so that a number of pieces could be strung together. In the celebrated Grave Creek mound, in Western Virginia, 150 such pieces were found in one spot, all of the same size, oval in shape, about the thickness of writing-paper, and with a small hole at one end. Evidently they were intended to be strung on a cord and form a belt or sash. Sometimes large plates are found, as one in a mound in Circleville, Ohio, which was 3ft. long, 18in. wide, and half-an-inch thick. It has been believed by some antiquaries that such slabs were used as mirrors. Evidently it was an article of considerable commerce among the Indians; and those of them who worked the mines of North Carolina evinced no despicable judgment, in spite of their rude implements. The kinds of mica now rejected were then rejected; and when they had mined more than they could transport, they hid it in pits. In one of these pits several cartloads had been discovered, which had been carefully packed and buried there.

A Range Finder.—A telemeter for finding the exact distance of the enemy has been invented by a Belgrade professor, according to the *Pall Mall Gazette*. The instrument is portable, being about the size of a watch, and remarkably accurate, as the error in the measurement of any range from 500 to 20,000 yards does not exceed $1\frac{1}{2}$ yards, nor does it increase with the distance, as in optical range finders, while the distance required to be known is shown

upon the face of the telemeter in less than a minute. Finally, the cost is only £2.

The Campylometer. — This name, meaning a curve-measurer, is applied by M. Gaumet to a small pocket instrument he has designed, for giving, at a single operation, and by a simple reading (1) the metric length of any line, straight or curved, traced on a map or a plan ; and (2) the natural length corresponding to a graphic length on maps with a scale of 1-80,000, or 1-10,000, or on maps whose scales are multiples or submultiples of these. The instrument consists of a dentated disc, five centimètres in circumference, mounted on a micrometric screw in a frame, with handle. The two faces of the disc carry each a system of border divisions, the one being into 40, the other into 50, parts. The circumference of the disc corresponds to four kilomètres on one of the scales just referred to, and to five kilomètres on the other; 1-40 of the disc on one scale, and 1-50 on the other, measuring 100 mètres). As the disc passes over the line it is desired to measure, it moves laterally along the micrometric screw, and in front of a graduated scale in the frame. Its zero having at the outset been brought to that of the scale, one has merely (the movement being terminated) to note the last graduation of the scale beyond which the disc has stopped, and to add to the value of this graduation the complementary length furnished by the division of the disc opposite the scale. The advantages of such an instrument on military marches and in many other cases

The Temperature of Town Water Supplies.—A paper was read before the British Association on "Temperature of Town Water Supplies," by Mr. Baldwin Latham, C.E., M. Inst. C.E.

In this paper the author pointed out that summer diarrhoea and cholera became prevalent when the water supply of a district arrived at a temperature exceeding 62 deg. Fahrenheit, and he showed that the changes which took place in water at a high temperature influenced the diseases referred to, and not atmospheric changes. In corroboration of this he referred to districts in which the water was invariably cold in summer, and which consequently were not subject to those epidemics. In districts where the source of supply, when distributed through the mains, was from a well which was naturally cold—as, for example, in the district supplied by the Kent Water Works Company, compared with the districts in London supplied from the river Thames—the former source of supply being so much colder at its source than the latter, the ground required a higher degree of temperature to raise that of the Kent water to a dangerous point, and thus the incidence of the disease in the districts supplied with that water fell later than in those supplied with Thames water; whereas if the cause were due to atmospheric temperature the incidence of the disease should have been identical in both districts.

The author further pointed out that great changes in the temperature of water were due to the temperature of the ground at the

depths at which the mains were laid; that the temperature of the ground might be made use of in a special apparatus patented by Professor J. T. Way and the author, by which water was made to descend to a depth of about 25ft. by means of a vertical tube driven or screwed into the ground, so that the temperature of the water was rendered nearly uniform throughout the year. A greater range than 3 deg. would not practically occur in such a tube; whereas in Croydon, where there was a constant water supply, the range in the temperature had been 27·6 deg., and a cistern supply gave a range of 38·7deg. By keeping the temperature of the water between the limits of 49deg. and 52deg., through the apparatus referred to, it was explained that summer diarrhoea could, in a great measure, be prevented.

The Garrett Submarine Torpedo Boat.—This is a new torpedo boat, invented by the Rev. G. W. Garrett, and besides being capable of being used as a most formidable weapon afloat, has the power of sinking and remaining under water for very many hours, and thus can easily enter any blockaded port unperceived. No compressed air is carried, but the air in the boat is maintained at its normal composition by a chemical apparatus invented by Mr. Garrett. When under water, also, no smoke nor gas is given off, although an engine of considerable power is kept in motion. Various experiments with the vessel have been made in the Great Float, Birkenhead, before setting off on a voyage to Port-

smouth. On December 10th, 1879,

Mr. Garrett, Captain Jackson, and Mr. George Rice, engineer, entered the boat, to start for Portsmouth ; but after thirty-six hours' journey in thick fog—a great part of the time being spent under water—they were obliged to put into Rhyl, as there are not many comforts on board for an extended trip. The boat, the inventor tells us, is in every way a success, and will easily perform what has been expected of her, and it thus becomes one of the most deadly weapons of naval warfare.

The Beginnings of Writing.—On 12th February, 1880, the Rev. A. H. Sayce, M.A., Deputy Professor of Comparative Philology in the University of Oxford, lectured at the London Institution on the history of writing. He began by referring to the pictures of reindeer and other animals scratched by neolithic men on horns and mammoth tusks, and then to the still more remarkable discovery made last summer of like engravings on the teeth of the cave-bear in a deposit belonging to the palaeolithic age. He threw out the suggestion that picture-drawing might even have preceded articulate speech and have helped in its creation.

Next he explained how writing begins with pictures of objects, and slowly develops, through the representation of ideas by means of ideographs, into a syllabary, and lastly into an alphabet. This he illustrated from the Chinese characters and from the various kinds of cuneiform writing, ending with the purely alphabetic Persian script. In the eighth century before our era, the Assyrian mode of writing was adopted by the

tribes then dwelling in Armenia and Media, and the first great reform in it was made by limiting each character to the expression of one single sound, the writing ceasing to be polyphous, but still remaining syllabic. The Persians, when they borrowed the syllabic signs, stamped them with an alphabetic value—such as *b* for *bu* or *ba*. Professor Sayce next gave a most interesting account of the development of the Egyptian hieroglyphics, and traced the descent of our Western alphabets from the Egyptian writing of the Middle Empire in the hieratic or cursive script. The pedigree was through the Latin and Greek to the Phoenicians, of the same race as the Hykshos or Shepherd Kings, who conquered and ruled Egypt from the 15th to the 17th dynasties. These enterprising and inquisitive strangers did for the hieroglyphics what the Egyptians themselves had failed to do.

The lecturer, who has but just returned from visiting Egypt, said that for some centuries after the fall of the Old Empire (B.C. 3500) Egypt was given over to decay, but it was while the elder Pharaohs of hundred-gated Thebes were still adorning that capital with temples and granite colossi, and excavating tombs for themselves, that the forerunners of the Hykshos arrived in the Delta, about B.C. 2700. They were a small body of immigrants, only 37 in all, shepherds and cowherds from Phœnicia, and, as if with an instinctive realisation of the great part their kinsfolk were afterwards to play in the history of Egypt and of mankind, their

arrival was commemorated in paintings and hieroglyphics on the walls of one of the tombs at Beni Hassan. There might still be seen portrayed in vermilion and ochre, with hooked noses and black hair, the features of the Shepherd Kings, who subsequently held Northern Egypt for 600 years, as well as of the Children of Israel, and of the later population of the Delta, as some say, down to the present day. For a time came when the Egyptians were driven out from these rich lands, the first seat of their power and civilisation, and their places taken by the traders of Tyre and Sidon, and the agricultural tribes of Southern Canaan. Henceforward the Delta received a new name among the Pharaoh's liegemen, being called Caphtor, or "Greater Phœnicia."

It was to these Phœnician settlers in Egypt that we owed our present alphabet. Their commercial instincts taught them the value of the Egyptian graphic system, all of which, however, they threw overboard, with the sole exception of what they could turn to business account. Discarding its ideographs, syllabic signs, and determinatives, their practical bent enucleated their 22 characters, from the first pair of which our word alphabet is derived. Having shown the process by which the transformation was effected, Professor Sayce ended by pointing a moral from the history of writing, that moral being that we ought to reform, not, indeed, our spelling, but our alphabet.

The New Flying Sounding Apparatus.—At the meeting of the British Association Sir W.

Thomson brought before the assembled members an ingenious mode of keeping out air and admitting water into his new flying sounding apparatus for navigation. It is simply the utilisation of fine cambric, which, while it is wet, allows water to pass freely, but is impervious to air of low pressures. The apparatus now works perfectly, and soundings can be taken between 11 and 70 fathoms while steamers are going at full speed.

A New Life Preserving Coat.

—A new life preserving coat has been invented by a gentleman of Sheffield, who recently publicly tested it at the baths of that town. A chemical preparation is inserted between the lining and the cloth, being placed on each side of the breast and up the back. The moment a man falls into the water the coat inflates, and he cannot keep his head beneath the waves. An attendant having put on the coat first went under a shower bath, where he was thoroughly drenched, to show that inflation would not take place under the ordinary circumstances of a shower, and accordingly the coat in no way altered its proportions. He then took a header and reappeared at the surface with the coat promptly inflated, and entering a part of the bath deep enough to take him up to the eyes, he could not touch the bottom at all, the water scarcely reaching up to his chin. The inventor states that his apparatus, which would simply form an additional lining inserted in a portion of the garment, would sustain a person in the water as long as he could possibly endure the

exposure, being effective for 45 or 50 hours. In the event of a person losing consciousness the lining in the back would form a sort of bed, and that in the breast a pair of pillows against which his head would rest.

A Viking's Ship.—Near the bathing establishment of Sandefjord, Christiania, Norway, there is a tumulus locally known as King's Hill. Under this tradition averred that a mighty king had been buried, with costly treasures near his body. Till lately, either owing to superstition or some similar sentiment, the remains had apparently lain undisturbed. Last January, however, the peasants on whose land the tumulus was situated began to sink a well. On reaching some timber, they prudently summoned the services of an able antiquary, and under his guidance the whole body of an old Viking vessel was revealed, 74 feet long between stem and stern, 16 feet broad amidships, drawing 5 feet, and with 20 ribs. This is far larger and more complete than the ancient vessels discovered in 1863 at Nydam, and in 1867 at Tune. It is evident that when the burial took place the sea (which is now a mile away) washed the base of the tumulus. The craft is placed with her stem towards the sea, so that when the Great Father should call him, the chieftain might start fully equipped from his tomb. Among the articles found in the vessel were some smaller boats, a quantity of oars, and some shields ranged along the freeboard, and too thin to be used for any but ornamental purposes. On entering the funeral chamber the explorers were disappointed. Some one, either in ancient or modern days, had been there before them, and had carried off all the more cherished treasures. Bones of man, horse, and dog, together with various utensils, drinking cups, &c., were, however, found. The tumulus is supposed to date from about the year 800, when Karl the Great (who has been Frenchified into Charlemagne) was crowned Emperor of Rome, and when Norway was still divided between the wild chieftains and sea-kings.—*Graphic.*

French Provincial Museums.

—An interesting paper on these museums, in the *Revue des Deux Mondes*, by M. Houssaye, gives the following among other information:—Nearly all the important towns have now a museum (though there are some anomalies), and some towns have 2 or several, as Lyons (3), Bordeaux (4), Marseilles (2), Rouen (3), Nancy, Limoges, and Orleans (2 each). In some places, as Lyons, Narbonne, and Toulouse, distinct museums are housed in the same building, each with its own curator; in other places, they are in different parts of the town.

To compare as to paintings: it is stated that the Louvre has about 2,200 (exhibited) paintings; the Florentine Gallery (*Gli Uffizi*), 1,300; the National Gallery, 2,000; the Museum of the Fine Arts Academy of Venice, 500. Now, the museums of Avignon, Bordeaux, Dijon, Lille, Lyons, Montpellier, and Rouen each contain 600 to 800 paintings, and those of Caen, Marseilles, Nîmes, Orleans, Toulouse, and Tours 400 to 600. The museums of Douai,

Havre, Nancy, Blois, Narbonne, and Rennes have 200 to 400 ; those of Brest, Melun, and Avranches not over 100, &c. From the administrative point of view, the museums of the departments are classed in 3 categories—national, departmental, and communal or municipal museums.

There are only 3 national museums outside of Paris—viz., the Versailles Museum, the Archaeological Museum of St. Germain, and the Ceramic Museum of Sèvres. These are organised and managed like the Louvre and the Luxembourg, belong to and are maintained by the State, which nominates their curators and owns their buildings. The departmental museums (pretty numerous) belong to the departments, and most often to the learned societies which have founded them, the prefect or the society nominating the curator, who is rarely paid, or the managing committee, sometimes appointed instead. These museums have allowances from general councils, learned societies, and (though rarely) municipal councils; but the last always supply the buildings. Nearly all of this class of museums are archaeological. The principal are those of Rouen, Sens, Epinal, and Orleans.

The communal or municipal museums are much more numerous ; they belong to the towns and are managed under surveillance of the municipal councils. In some large towns, as Bordeaux, Marseilles, Toulouse, two committees are appointed with the curator, one being consultative, for acquisitions, and formed of artists or amateurs of the town. In most the curator is not salaried, summer and autumn, at Mont-

but in some large towns he receives 1,000f. to 4,500f. The buildings belong to the town. These museums receive allocation from the municipal council, rarely from the general council. One must not judge the budget of a museum by the importance of the latter or of the town containing it. The budget of Marseilles museum is some 20,000f. and that of Toulouse museum 15,000f.; whereas Rouen has only 9,000f. and Bordeaux 7,000f. The small museum of Béziers has a budget of 3,500f., and the important one of Orleans only 1,800f. Lisieux affords its museum 200f. per annum, and some municipal councils do not vote a *sous* for the museum. Some museums have a certain income from legacies. On the whole, however, the communal museums appear to be but poorly supported.

Bacteria in the Air.—By a certain process M. Miquel has succeeded in seizing and numbering the spores or eggs of bacteria, and while confirming M. Pasteur's observation, that they are always present in the air, shows that their number presents incessant variations. Very small in winter, it increases in spring, is very high in summer and autumn, then sinks rapidly when frost sets in. This law also applies to spores of champignons, but while the spores of moulds are abundant in wet periods, the number of aerial bacteria then becomes very small, and it only rises again when drought pervades the soil, a time when the spores of moulds become rare. Thus, to the *maxima* of moulds correspond the *minima* of bacteria, and reciprocally. In

souris, one finds frequently 1,000 germs of bacteria in a cubic mètre of air. In winter the number not uncommonly descends to four and five, and on some days the dust from 200 litres of air proves incapable of causing infection of liquors the most alterable. In the interior of houses, and in absence of mechanical movements raising dust from the surface of objects, the air becomes fertilising only in a volume of 30 to 50 litres. In M. Miquel's laboratory, the dust of five litres usually serves to effect the alteration of neutral bouillon. In the Paris sewers infection of the same liquor is produced by particles in one litre of the air.

These results differ considerably. It is pointed out, from those published by Tyndall, who says a few cubit centimètres of air will, in most cases, bring infection into the most diverse infusions. M. Miquel compared the number of deaths from contagious and epidemic diseases in Paris with the number of bacteria in the he period from December, 1879, to June, 1880, and, certainly, each recrudescence of the aerial bacteria was followed at about eight days' interval by an increase of the deaths in question. Unwilling to say positively that this is more than a mere coincidence, he projects further observations regarding it.

M. Miquel further finds (contrary to some authors) that the water vapour which rises from the ground, from rivers, and from marshes in full putrefaction, is always micrographically pure, that gases from buried matter in course of decomposition are always exempt from bacteria, and that even

impure air sent through putrefied meat, far from being charged with microbes, is entirely purified, provided only the putrid filter be in a state of moisture comparable to that of earth at 0°30 mètres from the surface of the ground.

The Colour of Double Stars.—In view of the uncertainty of data by different observers as to the colours of double stars (revolving round each other), Herr Doberck recently undertook a statistical treatment of the observations of one astronomer, viz., Struve (in his *Mensurae Micrometricæ*). He formed tables in which, for every colour of the principal star, the number of individual colours of the companion is given separately. One sees at a first glance that there are, in general, two classes of double stars that revolve round one another. The first consists of bodies whose colours are identical, while the other contains bodies whose colours are in general complementary. The principal star in both cases is white or yellow; white stars are very common in systems of the first kind. The principal star is never blue, but the companion is often blue; and Herr Doberck's five tables, in which the stars are collected according to their distance, show that the number of blue companions quickly increases with the distance, while the members of pairs very close together are exactly alike in colour. The following numerical values are given:—The colours of 270 principal stars are:—golden 8, yellow 35, yellowish 57, yellowish-white 15, white 103, very white 23, greenish-white 28, bluish-white 1; on the other

hand, the colours of the 270 companions are:—reddish 3, golden 3, yellow 14, yellowish 35, yellowish-white 18, white 96, very white 17, greenish-white 6, ash-colour 23, bluish 24, blue 23, purplish 4, purple 4.

An Improved Heliograph.—Dr. Tempest Anderson, at the meeting of the British Association, claimed to have contrived a heliograph or sun telegraph by which the rays of the sun can be directed on any given point with greater ease and certainty than by any instrument at present in use. When the sun's rays are reflected at a small plane surface, considered as a point, the reflected rays form a cone, whose vertex is at the reflector, and whose vertical angle is equal to that subtended by the sun. Adding to the size of the mirror adds other cones of light, whose bounding rays are parallel with those proceeding from other points of the mirror, and only distant from them the same distance as the points on the mirror from which these are reflected; hence, increasing the size of the mirror only adds to the field to which the sun's rays are reflected a diameter equal to the diameter of the mirror, and this at any distance at which the sun signal would be used is quite inappreciable.

By the author's plan an ordinary field-glass is used to find the position of the object to be signalled to, and it is attached in the position of the ordinary sunshade, a small and light apparatus, so arranged that when the mirror is turned to direct the cone of rays to any object within the field of view of the glass an image of the

sun appears in the field at the same time as the image of the distant object, and magnified to the same degree, and the part of the field covered by this image is exactly that part to which the rays are reflected, and at which some part of the sun's disc is visible in the mirror. In this way not only was a larger space covered, but flashes were more vivid and useful.

Raising Sunken Objects.—A change in the well-known method of raising sunken objects by means of balloons has been proposed by Herr Raydt, of Hanover, in that he uses gas condensed in vessels to a liquid state, and lets it expand into the balloon under water. Carbonic acid is recommended as the most suitable gas. The balloon is made of strong canvas, saturated with caoutchouc solution and lined thickly with caoutchouc. Above and below it has metallic plates, to which an envelope of network is connected. These plates are connected in the direction of the balloon's vertical axis by a metallic pipe having numerous apertures for admission of gas from the reservoir, which is of thick zinned iron, and is attached by screwing its entrance pipe to the pipe projecting from the lower plate, both of which pipes are furnished with cocks.

Where a sunken vessel has to be raised, the balloon is let down in a collapsed state, with attached reservoir; the diver admits only a little gas at first, so that the balloon may support itself, then he fastens the balloon to chains passing round the vessel. The communication between reservoir

and balloon is then fully opened, so that the latter is inflated and exerts lifting force. A balloon 3 mètres in diameter has in sea-water at 10° C. a lifting force of 116,464kg. The cold developed by the expanding gas has little or no prejudicial effect; at most it freezes a portion of the gas, and renders the inflation somewhat slower. As, with the rise of the balloon, the external pressure gradually diminishes, automatic air-valves are provided in the lower plate to allow escape of gas when its pressure is apt to become excessive. Such balloons may be attached pair-wise to chains passing round a ship. Another useful application of the principle is that of giving divers a ready means of coming up to the surface; two collapsed balloons are carried on the back, and a supply of liquefied gas on the breast. In the moment of danger, the diver releases the balloons and lets the gas enter them. Ammonia gas is recommended for this rather than carbonic acid, which might be liable to explode through becoming heated; a vessel of two litres capacity would suffice. The practicability of Herr Raydt's method was lately demonstrated at Kiel, when, before numerous spectators, an anchor-stone weighing 306cwt. was raised from a depth of 10 mètres by means of a balloon 3 mètres in diameter.

Hippophagy in France.—Some very interesting statistics have been published by the society for promoting the use of horse flesh and the flesh of asses and mules as food, showing how steadily the consumption of these articles of diet has been increasing in Paris

and the provinces since the foundation of the society in 1866. The weight has increased from 171,300lb. in 1866 to 1,982,620lb. in 1879. In the principal cities of the provinces the consumption of horse flesh may be considered to have fairly taken root. At Marseilles, in 1870, there were 599 horses eaten; 1,031 in 1875, and 1,533 in 1878. At Nancy 165 in 1873, over 350 in 1876, and 705 in 1878; at Rheims 291 in 1874, 423 in 1876, and 384 in 1878; at Lyons, 1,839 in 1873, and 1,313 in 1875. In both the latter cases some difficulties had been thrown in the way by the town authorities, as was the case recently at Chalons-sur-Marne, where the mayor fixed the price of the horse flesh at a higher rate than that of beef.

The average price of horse meat is from 25c. to 30c. per lb. Each horse furnishes about 200 kilogrammes (4cwt.) of meat, which is capable of being prepared in many by no means unappetising ways, such as *pot-au-feu*, boiled, roast, hashed, haricot, jugged, filet, &c.

A New Application of Instantaneous Photography.—Mr Maybridge's method of photographing horses in rapid motion has lately been applied in San Francisco to the study of human action, particularly that of athletes while performing their various feats. In order to display as completely as possible the movements of the actors' muscles, they wore brief trunks only while performing, and thus all the intricate movements of boxing, wrestling, fencing, jumping, and tumbling were instantaneously and exactly pictured. The first experiment

consisted in photographing an athlete while turning a back somersault. He stood in front of the camera motionless, and at a signal sprang in the air, turned backwards, and in a second was again in his original position. Short as was the time consumed, 14 negatives were clearly taken, showing him in as many different positions.

The same man was also taken while making a running high jump. The jumping-gauge was placed at the 4-foot notch, in order to give an easy jump, for in making it 14 stout hempen strings had to be broken, as in photographing trotting horses. From the camera to a point beyond the line on which the jump was made a number of strings were stretched. The two base-lines were only a few inches above the ground, and from them to the apex the strings were placed equal distances apart. In jumping, seven of the strings were broken in ascending and seven in descending. The strings were taughly drawn, and so connected with the camera that as each one parted a negative was produced. Other pictures were taken of men raising heavy dumb-bells and the various movements of boxing, fencing, and the like,

Velocity of Projectiles in Guns.—The methods that have been tried for ascertaining the law of motion of a projectile in the bore of a gun (with a view to finding the law of pressures developed) give only a small number of points of the curve of spaces traversed in given times, and they

involve perforation or other injury to the walls of the gun, so that they are applicable only to large

pieces. A new and ingenious method, advantageous in these respects, has been contrived by M. Sebert. In the axis of a cylindrical hollow projectile he fixes a metallic rod of square section, which serves as guide to a movable mass. This mass or runner carries a small tuning fork, the prongs of which terminate in two small metallic feathers, which make undulatory traces on one of the faces of the rod (blackened for this purpose with smoke) as the runner is displaced along the rod. The runner, it will be understood, is situated at first in the front part of the projectile, and while the latter is driven forward remains in place, the rod of the projectile moving through it. The escape of a small wedge between the prongs of the fork at the moment of commencing motion sets the fork in vibration. It can be easily shown that, owing to the very high speed imparted to the projectile, the displacement in space of the inert mass, through friction and passive resistances, which tend to carry it forward with the projectile, is such as may be quite neglected, so that the relative motion of the mass recorded by the tuning fork may be considered exactly equal and opposite to the motion of the projectile. A study of the curves produced guide to the laws of the motion and of the pressures developed by the charge. Evidently the motion of a projectile as it buries itself in sand or other resistant medium may be similarly determined.

Lighting of Railway Carriages in Germany.—From reports recently obtained from the various

German railway authorities it appears that the present state of the lighting of carriages is as follows:—For lighting material, rapeseed oil, gas, and to a considerable extent even candles, are used. Of some 16,168 carriages adapted for illumination 10,968 (or 67·8 per cent.) are lit with rapeseed oil, 2,653 (or 16·4 per cent.) with gas, and 2,247 (or 15·8 per cent.) with candles. In addition, experiments have been made on some lines with the so-called Mohring oil, which is a mixture of petroleum and rape-seed oil. The gas used is partly made in works belonging to the railway, from fat, paraffin, petroleum, gas oil, or coal-tar oil, partly obtained from gas manufacturers. The gas-holders, in which gas can be compressed to 5½ or 6 atmospheres, are fixed under the carriages, and connected with the burners by means of tubes with regulators of pressure and valves. The filling of the holders is accomplished either direct from the gas works by means of caoutchouc tubes, or through transportable gas reservoirs, which can be filled with five to six cubic mètres gas pressed to 10 atmospheres, or from small vessels. A single filling of a gasholder suffices for 30 or 40, or even 60 hours' burning. The average cost given by the authorities, per flame and hour of burning, varies in the case of gas between 2 pfennigs and 3·37 pf.; in the case of oil, between 0·667 pf. and 7·5 pf.; and in the case of candles, between 1·8 pf. and 6 pf.

A New Way of Heating Railway Carriages.—It is reported from Lyons that the Compagnie Paris-Lyon-Méditerranée is now

trying a new method of heating in express trains. The method was proposed by M. Ancelin, an engineer, and consists simply in the use of acetate of soda in the foot-warmers. The substance has considerable latent heat: dissolving at a certain temperature, it thus absorbs a large quantity of heat, which becomes sensible during crystallisation in cooling. All that is required is to fill the ordinary cases with a sufficient quantity of the acetate, close them, and place them in a stove at about 100°. The cooling of a case thus charged and heated takes 12 to 15 hours. The warmers are thereafter taken from the compartments and placed in a stove (where the crystals of soda acetate are re-dissolved): they are then ready for fresh use. The advantages of such a system are obvious—no necessity of changing warmers every 2 or 3 hours, or of maintaining a numerous body of men at stations to attend to them, economy in cost of heating, &c. Moreover, most of the existing foot-warmers can be utilised. Acetate of soda is not very expensive, and it could easily be manufactured in much larger quantities than at present if the demand required it. The new system has been tried on the express train No. 5, leaving Paris at 7.15 and reaching Perrache at 4.31. The compartments were each supplied at starting with 2 warmers containing acetate of soda. At Perrache most of the warmers were still so hot that one could not apply the back of the hand to them. From Lyons to Marseilles the train was heated on the ordinary system.

Discovery of Sanskrit Texts in Japan.—Japan has had many surprises in store for us, but certainly none, it would seem, more astounding than the discovery of Sanskrit texts in its ancient libraries; and yet we are told that Sanskrit scholars had long been upon the alert, and had for years been making inquiries as to the whereabouts of these literary treasures that are now coming to light in Japan. Japan is Buddhist. Out of its 34,388,300 inhabitants, 100,000 only seem to belong to the old Shinto religion. The rest are all followers of Buddha, though divided into numerous sects. The heart of Buddhism beat in India, and it was from India that the life-blood of that religion flowed in all directions to the very extremities of the Asiatic continent. About the time when Nero was bent on exterminating Christianity in the West, the Emperor of China opened his vast empire to the religion of Buddha, and received its missionaries with open arms.

From that time onward—i.e., from the middle of the first century of our era—India became the Holy Land of China. In spite of the difficulties, which even now seem insurmountable to our most adventurous travellers, ambassadors and pilgrims made their way from China to India undismayed by the dangers of the road, and they brought back to their native country, not only statues of Buddha and sacred relics, but thousands of Sanskrit MSS., which were translated into Chinese by the combined labours of Indian and Chinese scholars. Several of those Chinese pilgrims have left

us accurate descriptions of their travels, and it was the translation into French by the late Stanislas Julien of the *Travels of Hiouen-thsang* (629-645 A.D.), published in 1853, which filled Sanskrit scholars with the conviction that some of the masses of MSS. which had been carried from India to China must still be in existence in the temples and monasteries of that country.

It was chiefly due to the late Professor H. H. Wilson that a systematic search was instituted in China for the recovery of Sanskrit MSS. Sir John Bowring and Dr. Edkins did all in their power to carry out Professor Wilson's instructions. The whole correspondence on the subject is published in the "Journal of the Royal Asiatic Society," 1856. But, unfortunately, the result was *nil*. Though there was an enormous amount of Buddhist literature, translated from Sanskrit into Chinese, the original Sanskrit MSS. seemed all to have vanished.

Sanskrit scholars, however, were not disheartened. On the contrary, they turned their eyes from China to Japan, as the last hiding place of those MSS. which, 1,800 years ago, had been carried away from India to China. Though Buddhism did not reach Japan direct from China, but from Corea, it was known that Buddhist priests came from Japan to study in China, and that several of them had been pupils of that very Hiouen-thsang whose travels in India, as translated by Stanislas Julien, had given the first impulse to the search for Sanskrit MSS. in China. Some years ago Dr.

Edkins, the learned Chinese scholar, who had formerly assisted Professor Wilson, sent a small vocabulary printed in Japan to Professor Max Müller. It contained Sanskrit words, explained in Chinese, and transliterated in Japanese. This proved that at one time or other Sanskrit had been studied in Japan.

Another piece of good luck followed soon after. One of the greatest Buddhist communities in Japan sent a young Buddhist priest, Mr. Bunyin Nanjio, to Professor Max Müller at Oxford, in order that he might learn Sanskrit and Pali, and thus be able to read the sacred writings of Buddha in the original. Professor Max Müller urged his pupil to make inquiries through his friends at home for Sanskrit MSS., and in December last a learned Buddhist priest, Shuntai Tshikawa, sent the Professor a book containing one of the sacred texts of their religion in the original Sanskrit. The Sanskrit was written in the old Nepalese alphabet, each word transliterated with Japanese letters, and translated into Chinese. He requested Professor Max Müller to read the text, correct it, and send it back to Japan. Though the Sanskrit was written in a difficult alphabet, and full of mistakes, Professor Max Müller was able to lay a correct copy, with translation and notes, before the members of the Royal Asiatic Society at one of their meetings. It turned out to be the hitherto unknown Sanskrit original of a Sūtra, translated into Chinese 400 A.D., possibly 200 A.D., and contained a description of the Buddhist Paradise, which, with

the Northern Buddhists, took the place of Buddha's Nirvāna.

It may be hoped that new treasures will be forthcoming from the same quarter. Anyhow, this one discovery has proved two important points — first, that the Chinese translations of Buddhist texts, when compared with their Sanskrit originals, are full of misunderstandings, sometimes affecting the very essence of Buddha's teaching ; secondly, that the Buddhism of Japan, being chiefly founded on the Mahāyāna school, is on many points in direct opposition to the original teaching of Buddha, and that no greater boon could be conferred on the 30,000,000 of Buddhists in that country than to have the simple words of Buddha translated for them into Japanese direct from Sanskrit and Pali.—*Times*.

Fleuss's New Diving Apparatus.—A lecture was delivered by Dr. B. W. Richardson, F.R.S., early in May, 1880, on "Fleuss's New Diving Apparatus."

The lecturer began by giving a short history of the successive attempts to render life possible under water for a considerable time. The history of diving bells and similar apparatus began about 1548, and Schott, in his "Technica Curiosa," in 1554, said that he saw in Spain two Greeks who went under water with weighted kettles in which they could carry a candle, and in this way they could live under water for a considerable time. This he called the aquatic kettle; elsewhere he spoke of it as aquatic armour. Lord Bacon also gave a description of a primitive method of diving, by which a bell was fixed on a tripod

in which a man standing on a shelf was enabled to descend into the water. The Hon. Robert Boyle also gave a singular story of Cornelius Disbel, who, in James the First's reign, was said to have made a submarine boat which could be rowed. A breathing medium was supplied by means of a fluid carried in the boat which gave off a vapour equivalent to air. But that was scarcely credible, as no such substance as peroxide of hydrogen, which was discovered in 1818, then existed. But that process would be too expensive, and the substance was now used for widely different purposes.

In 1678 Halle, who was the real inventor of the diving bell, sent men from the bell under the water with tubes through which a supply of air was kept up. Later Spalding made a helmet and cuirass, for which he received a medal from the Society of Arts. Trewal afterwards made a smaller bell, which could be carried about, and he first introduced lenses instead of flat glass.

In 1775 Smeaton for the first time used a pump. Mr. Martin, in his "Philosophia Britannica," refers to a diving dress holding half a hogshead of air, which enabled a man to live a considerable time in water. In 1798 tin-plate armour, with two pipes for inhaling and exhaling, was introduced. Subsequently the "open" diving dress was invented by Mr. Siebe, the air passing through the jacket. Afterwards the "closed" dress was invented by Mr. Siebe. No great further advance was made till 1854, when a Frenchman, Si-card, used compressed oxygen.

The dress was much like the ordinary diving dress; an apparatus was provided to carry off the carbonic acid of the breath, but there was a difficulty in removing the water of the breath, which impaired its usefulness.

Then came the dress invented by Mr. Fleuss, whose invention was worked out independently of all others. This apparatus was successful in large measure in removing the water. First there was a helmet, with a chamber inside strong enough to bear 16 atmospheric pressures. Under that pressure he could introduce enough compressed oxygen to supply breathing power for four hours. Then a cuirass with two metal chambers was put on, and the chambers were filled with porous indiarubber saturated with solution of soda. When the dress and cuirass were put on, the diver placed his mouthpiece in his mouth, which resembled the anaesthetic mouthpiece of Dr. Gibson. A large tube was placed in the mouth and connected with one of the chambers containing the soda. By this process the carbonic acid of the breath was removed. Part of the oxygen of the breath was also in this process reserved for future use and passed into the helmet. There was a tap to the helmet to admit the return oxygen. In this way a new atmosphere was in constant process of manufacture, and at the lower part was a trough to receive the water of the breath.

Mr. Fleuss showed the audience how to charge the helmet with air—a process which was effected in a very few minutes. The lecturer recommended the use of the appa-

ratus for fire engines and mines, as well as for water.

Mr. Fleuss then assumed the oxygen, Mr. Fleuss's apparatus dress in presence of the audience. The lecturer said that he had made experiments to ascertain whether health was impaired by the use of artificial air of this character. For this purpose, in very cold weather, Mr. Fleuss went down into the water, and stayed there at a depth of 12 feet for an hour. He walked about, and even reclined on the floor of the tank. On his return he felt numb, and the pulse was beating 120 in the minute, but the breathing was free. The temperature seven minutes afterwards was 94 instead of 98 2-5ths, but that was in consequence of the great cold. In a short time, however, all the functions speedily became perfectly natural. The lowest temperature of the body in this experiment was 92, six less than the normal rate. The pulse a little varied, but not to a dangerous degree.

Another experiment was made the following day, carbonic acid being used instead of water. Mr. Fleuss sat in the bell for 20 minutes without being at all affected. Lighter vapours were then used, as carbonated hydrogen and anyle hydrid. These experiments were equally successful. The inhaling of all these vapours was in ordinary circumstances dangerous, if not fatal. The question was how long a man could exist in such an artificial atmosphere. It must be granted that there was too much oxygen. But that could be regulated by the tap by which the supply was increased or diminished.

In extreme cases of heat or cold, owing to the use of pure oxygen, Mr. Fleuss's apparatus could not safely be used, though in all ordinary circumstances it might be successfully adopted. Many improvements might be suggested. It would be desirable to introduce improvements to enable the diver to take food, and so to stay for a much longer period under water; and in mines a telephonic apparatus might be devised. Dr. Richardson thought such improvements were perfectly feasible.

There were differences of opinion as to the depth in which the apparatus could be used. Mr. Fleuss had been 25 feet under water and had walked 400 yards. Mr. Siebe had said that divers had been 200 feet down, but that statement required corroboration. But 86 feet was a feasible depth. The apparatus would be extremely useful for other purposes than diving—e.g., for fires, in which a fire-proof dress might be used. In mines experiments had shown that the apparatus could be used in choke-damp; and it could be employed in wells and other places where a great quantity of carbonic acid was present. Mr. Fleuss then entered with his dress into a chamber filled with carbonic acid. The character of the atmosphere was sufficiently shown by Mr. Fleuss's inability to light a candle while in the chamber. The lecturer expressed a hope that further improvements might be made by devising a propelling apparatus by which submarine geographical research would be facilitated. He commended Mr. Fleuss for the courage which he had shown in testing his experiments on himself.

Talking Machine.—A machine with which a remarkably close imitation of human speech can be produced has been brought to this country by the inventor, Herr Faber, and exhibited to the Physical Society and privately, for closer examination of its mechanism, to several well-known scientific men. It opens up an entirely different set of questions from those suggested by the performances of the phonograph, which merely reproduces sounds uttered by the human voice. This talking machine will give intelligible utterance, more or less distinct, according to the words, to the ideas of the operator. The machine is the product of the continuous labour and study of two members of the same family. It was begun in 1815 by one Joseph Faber, and so far elaborated in 1841 that it was exhibited in that year to the King of Bavaria. The originator dying, bequeathed the machine to his nephew, the present owner, also named Joseph Faber, who had been associated with him in its construction, and since it became his property Herr Faber has almost doubled its powers of articulation. The chief points of interest the machine has for the physicist, the physiologist, and, it may be added, for the philologist, lie in the results obtained from the ingenious contrivances by

and mobile organs of voice are performed. The principal features of the machine are, to begin with, the bellows, from which the air is driven with considerable but varying force by means of a pedal lever. The air passes in a horizontal stream through a small

chamber, which represents the human larynx, and in the same right line out through the mouth. The lips and tongue are of india-rubber, and the lower jaw is movable. Below the laryngeal apparatus, and opening from the chamber in which it is contained, is another smaller chamber, about the size and shape of a lemon, from which a pipe curved upwards allows the air when driven through to escape. This supplies the place of the nose to the instrument, and when a valve is opened enables the sound of the letters "m" and "n" to be produced by the striking of the same keys with which the sounds of "b" or "p" are obtained. The larynx is, of course, the most complex part of the machine, and to Herr Faber is due the elaboration of this portion of the mechanism. Within a small oblong box, a narrow and exceedingly thin strip of hippopotamus bone, strengthened by india-rubber on one side, produces by its vibrations the speaking tone, which may be called the fundamental sound to be subsequently modified. At the will of the operator the pitch can be raised or lowered, but not during the utterance of a word or sentence, so that in saying "Mariana," or "*Comment vous portez vous?*" (the machine talks French, German, Italian, or English), the key-note remains unaltered to the end. In front of the vocal chord and within the laryngeal chamber are stops or diaphragms, placed vertically, and rising and falling like the wards of a Chubb's lock, but different, in that each stop is a complex machine in itself, having within, moved by a spring, another stop,

by means of which an orifice at the base is enlarged or diminished. Herr Faber has taken another liberty with nature, for besides placing the nose below the mouth, for the sake of convenience, he has placed the teeth in the larynx, or more strictly speaking, with one of these stops he gets a somewhat lisping "s" or the sound of "sh" from the machine. A small windmill-like arrangement gives the rattle to the letter "r," and a thin iron band, notched in the lower rim in front, fitting outside the upper lip, descends to give the "f" or "v" sound. There are 14 keys by which sounds are controlled. Striking the first sound of "a" in "father" is produced, the mouth remaining wide open; another key being struck the lower jaw rises and the sound of "o" in "bowl" is given; a third key moves a lever which nearly closes the mouth and the sound of "o" in "movement" is emitted. The other vowel sounds and the consonants are produced by the use of the diaphragms in the larynx with the mouth in the second or third positions.

Artists' Materials.—A meeting was held in June, 1880, in the Grosvenor Gallery, New Bond Street, to discuss this subject, to which considerable attention had been directed earlier in the

Mr. Holman Hunt exhibited several canvases, upon which different colours and combinations of pigments had been laid some years ago with a view to see what changes would take place. Many had changed considerably. With regard to one canvas, Mr. Hunt said that, wishing to try some Indian colours that had been sent

to him, and having no oil at hand, he sent out and bought a bottle of oil bearing upon it the name of a celebrated dealer, and used it to mix with the colours. That was in March, 1879, and the colours on the canvas were still as wet as on the day they were laid on.

In the discussion which followed, Mr. E. Fielding pointed out that there were different modes of preparing vermilions and other colours, and that much would depend upon the particular method adopted. With regard to the vehicle, the artists' colourman had to trust very much to the varnish-maker, the composition of the vehicles being trade secrets.

Mr. Arthur West made an interesting communication with reference to a book formerly belonging to Mr. Field, and now in the possession of a firm of colourmen. This contained directions for the preparation of colours, of which specimens in the book had been produced about 70 years ago, and were as perfect in tint now as when first put in.

Mr. Church, Professor of Chemistry, of the Royal Academy, said it was now about a quarter of a century since he first began to make experiments with pigments, oils and varnishes, and painting grounds. The movement which Mr. Hunt had begun must, it appeared to him, take a wide range. To begin, for instance, with the oils to which reference had been made. The best colourmen were at the mercy of the oil-seed crushers. It might be East Indian, Russian, or Italian oil-seed; and these would vary greatly. Taking the worst of them—the East Indian—that

would be found to contain a certain percentage of non-drying oil, due partly to the presence of mustard and rapeseed with the linseed, and partly to the fact that from seed crushed by hydraulic pressure at a high temperature a not inconsiderable quantity of fatty matter would be expressed. After speaking of the effects of mixing various pigments, he mentioned, by way of example, that there were three varieties of Prussian blue, of which only one was permanent, but which might be easily distinguished by the employment of certain chemical and physical tests. In making experiments with colours he would suggest that the pigments should be spread on glass first, because the preparation of the ground on the canvas might vitiate the experiment. Next, the colours should be laid on white porcelain, because any change of tint could then be better observed; and, thirdly, some should be put upon canvas, the composition of the priming of which was known.

Other speakers followed, and Mr. Joseph Stapleton having given the results of analyses of colours made by him for Mr. Holman Hunt, Sir Coutts Lindsay summed up the discussion, and said that the meeting had not been held fruitlessly. Some valuable and interesting information had been obtained from various speakers. From what they had heard he would venture to say that Mr. Hunt had been amply justified in the course of action he had taken in calling attention to this subject. Mr. Hunt had not attempted to prejudice the public in any way against

the colourmen. He had only asked that inquiry might be made respecting the colours used by artists. So far as the matter had yet been investigated, there appeared to be grounds for a careful consideration of the subject. There could be no doubt that there were many colours which might be very good in themselves, but were sold under false names. These colours might be quite harmless, but the practice of selling anything under a false name was misleading to the artist and deserved reprobation. He believed, as one speaker had said, that there were no more honourable men as a body than artists' colourmen, but they were constantly forced by the demands of the artists to sell things in a way they would not wish to do. Artists wished pigments to have qualities which those pigments in their nature had not. For instance, they wanted Naples yellow to have a very brilliant, bright colour, and to satisfy this desire for brightness the colourmen were induced to produce something which was not really Naples yellow at all. Artists were, he thought, quite as much to blame for the present state of things as the colourmen. They and the colourmen were not in proper relations with each other. The colourmen wished to please the artists, and the artists were very often unreasonable in their demands. He hoped that the outcome of this meeting would be the awakening of an interest in the subject on the part of the public.

The St. Gothard Tunnel.—On the 29th of February, 1880, the

task of piercing the tunnel beneath the St. Gotthard was completed; the last blast was fired, the two galleries which had been approaching each other from either end were thrown into one long tunnel, and the opposite gangs of workmen rushed into each others arms and exchanged congratulations on the successful accomplishment of their task. We are accustomed to the triumphs of science, yet the forcing of a way for the iron horse beneath the enormous mass of an Alpine range remains an achievement to be contemplated with admiration, if not surprise. After the Mont Cenis tunnel the St. Gotthard enterprise cannot be deemed a novelty, but it is a greater work. The Mont Cenis tunnel is seven miles and a half in length; the St. Gotthard is some two miles longer. The former was begun in August, 1857; the boring was completed in December, 1870; and it was opened for traffic in October, 1871. The total cost was about £2,600,000, which was mainly contributed by France. The cost of the St. Gotthard cannot be given except approximately at present, but it is plain that it will much exceed the sum just mentioned. It was in the summer of 1872 that M. Favre, the engineer, undertook to construct the St. Gotthard tunnel for £2,000,000, within the space of eight years. The promise was fulfilled as to time, but the financial estimate is a different matter. The line of railway which is to be carried through the tunnel presents other engineering difficulties which add greatly to its cost. There are, we believe, no less than twelve other tunnels of considerable extent and fifty-two lesser ones, which, with the nine and a half miles of the principal tunnel, make up a sum total of twenty-six miles. In addition to these there are sixty-four bridges, and all this is required on a line only one hundred and fifty miles long, so that the cost per mile may well be something enormous.

The piercing of the longest tunnel in the world has been achieved in seven years and five months—a rapidity of execution quite unprecedented, for relatively to its length the St. Gotthard has been bored in a fourth of the time occupied in the boring of the Hauenstein tunnel, and in less than half the time taken by the Mont Cenis. This great advance in the art of tunnel-driving is due to the more extended application of machinery, and above all to the efficiency of the air compressors invented by Professor Colladon, of Geneva. The perforators, actuated by these compressors, did their work with marvellous swiftness. In two hours one machine drilled twenty six holes 1·20 mètre deep in a face of rock some 2 mètres square. The holes were then filled with dynamite, charged, and fired, every explosion dislodging some 2½ cubic mètres of rock. The point of attack for the perforators was always the upper part of the finished tunnel of the future; the floor of the passage they cleared out being afterwards blasted and wrought down by hand to the required level. The locomotives used in the tunnel were moved by compressed air, and ventilation was provided from the same source. Horses were also used

for dragging the waggons, but owing to the intense heat and the closeness, the mortality among them was very great. Out of a stud of forty, ten died on an average every month. The men worked night and day in shifts of eight hours each ; the labour was very trying, and they were compelled to take frequent holidays. Great circumspection had to be exercised in the admission of outsiders to the galleries, as a walk of several miles in the stifling heat and vitiated atmosphere might easily have proved fatal to persons with weak hearts or a tendency to congestion of the brain ; and even the healthy who ventured in for the first time had often occasion to regret their temerity. The scene in the interior of the tunnel was weird in the extreme : the pitchy darkness relieved only by the glare of a few lamps, the shrieking of locomotives, the blowing of horns, the tramp of horses, the vibration of the perforators, the explosion of mines, the continual passing of heavily-laden waggons, the groups of naked men plying pickaxe, spade, and shovel — all these things mingled together created an impression never to be forgotten. The loss of life from premature explosions has been considerable, some 60 or 70 men having been killed, while many more have been seriously injured.

The northern, or Swiss entrance to the tunnel, is situated at Göschenen, a wild and barren place at the mouth of that picturesque little river the Reuss, while the southern, or Italian end, is at the village of Airolo, at the foot of the St. Gothard Pass.

To the tourist the opening of the tunnel will not be altogether a boon. He will be able to hurry on into Italy at a greater speed, but he will miss much which once made the journey to the lover of the picturesque well worth its occasional drawbacks. There is no great pleasure to be had from whirling through one tunnel after another. But there will be after all some very charming bits on the line between Zug and Lugano. (The two extremities of the great tunnel, it may be remarked, are Göschenen and Airolo.) Perhaps the most picture-que bit on the Swiss side will be the run along the side of the lake from Brunnen to Fleulen, although the nature of the ground necessitates many tunnels on the route. But the railway will never wholly supersede the road for the lovers of nature in its Alpine grandeur and beauty.

Diamonds in India. — In a paper in the "Journal of the Scientific Proceedings of the Royal Dublin Society," Mr. V. Ball, of the Geological Survey of India, gives an account of the mode of occurrence of diamonds in India and of their distribution, and adds references to the most important authorities on the subject.

There are in India three extensive tracts, widely separated from one another, in which the diamond has been sought for. The most southern of these has long borne a familiar name, which is, however, to a certain extent, a mis-

There are no diamond mines in Golconda. This name, originally applied to a capital town, now represented by a deserted fort in the neighbourhood

of Hyderabad, seems to have been used for a whole kingdom; but the town itself was many miles distant from the nearest of the diamond mines, and it was only the mart where the precious stones were bought and sold. The second great tract occupies an immense area between the Mahanada and the Godavery rivers; and the third great tract is situated in Bundelcund, near the capital of which, Punnah, some of the principal mines are to be found. The work of the Geological Survey has demonstrated that the diamonds occur in the Vindhyan rocks of Northern India. In the upper division of this formation there is a group of clay slate (Rewah), and in the lower a group of sandstone (Semri), in both of which diamond-bearing beds are met with. It is still very doubtful, however, if a diamond has yet been found in India in its original matrix.

Mr. Ball gives an account of the chief mines, describing in detail, from personal observation, that of Sambalpur, which has now for some time ceased to be productive. The Punnah mines are still productive, yielding a mean annual produce of between £40,000 and £60,000 a-year. Europeans have attempted diamond-mining in each of these three tracts, but in no one instance have their operations been attended with success, and yet there does not appear to be the least ground for supposing that there has been any real exhaustion of the locali-

peculation. It would almost seem that to work it profitably a system of slavery must be adopted. It is, therefore, to be distinctly understood that, except by a mere chance, diamond-mining will not prove a rapid road to fortune. "till," writes Mr. King, "for those content with a slowly-paying occupation and a hard life, involving close personal supervision of the workers, it would pay, provided such persons possessed capital sufficient to last them a few years."

English Spelling.—Mr. E. B. Nicholson, M.A., principal librarian of the London Institution, lectured, in March, 1880, in the theatre of the Institution on "English Spelling, Past, Present, and Future." Professor Sayce, he said, had lately reminded them that the alphabet in daily use among us was really a series of worn-out Egyptian pictures employed to paint sounds. They had been picked out of a far larger number of such hieroglyphics by the Phoenician conquerors of Egypt, and had been handed on by them to the Greeks, who passed them on to the Italians, to be transmitted in turn through Roman missionaries to ourselves.

Before treating of the modern period, the lecturer pointed out certain changes which preceded it, and which helped to explain some of its curious spelling and pronunciation. The relations of the letter "c" to "k" on the one side, and to "s" on the other, were copiously illustrated. But for the law and Court French of Norman copyists, kitten would

In diamond-mining there must necessarily be a considerable amount of individual handwork. There are immense facilities for probably have come to be spelt

like cat with a "c," and city with an "s." An account was given of the Runic "th," for which the printers still substitute "y," as in "ye olden time," although our forefathers never sounded the definite article "ye" any more than we do. It was remarked, however, that this burlesque spelling is interesting as the last lingering relic of the alphabet which our Gothic ancestors got from the Greek Black sea colonists centuries before the Saxons set foot in England. The Runic aspirate "d," represented by the "th" in thine, had left behind it no such trace in our graphic system, although it had made its mark in our etymology.

After showing that at a comparatively recent period "hw" was written where we now have "wh," and drawing important inferences from the fact, the lecturer pointed out what havoc printing has from the first wrought on our spelling. The present character of English spelling might be described as unphonetic. It was so in three ways. First, it had a great variety of sounds for the same sign; next, it had a great variety of signs for the same sound; lastly, it used signs having nothing to do with our words. The first letter of our alphabet had at least ten different sounds. As an example of a sound with a great variety of signs, there was the same letter's first sound, as in hate, which was spelt in 18 different ways. Some of the illustrations by which the third charge was established afforded at the same time amusing instances of the tyranny of typographers. To them we owe the "l" in could,

the "s" in island, the "g" in sovereign and foreign, rhyme for rime, and scythe for sithe. An instance of printers' pronunciation we had in whole for hole, which until Tyndale's time was never spelt with a "w," any more than hale, of which it is but another form. Tyndale's colleague Roy spelt wholy for holy. From these and other illustrations it was argued that our current system of spelling is a most unsafe guide to the derivation of words. The remainder of the lecture was devoted to the advocacy of spelling reform.

Luminous Paint.—At a meeting of the Society of Arts in March, 1880, Professor Heiton, of Charing Cross Hospital, gave a lecture on "Balmain's Luminous Paint." He commenced by stating the nature of fluorescent substances, showing examples of several under the electric light. Afterwards he alluded to phosphorescence, and detailed the history of the investigation of phosphorescences. Bacquerel, a Frenchman who lived about 30 years ago, discovered more than all the other investigators together, and Balmain, the inventor of luminous paint, had the advantage of studying at one time under him. The paint is made up either as an oil or water-colour, and its sensitivity to light is such that, as was shown by experiment, a piece of painted cardboard exposed to the sparks of an induction coil shows in the dark a photographic record of the sparks. On being exposed to light under different coloured glasses the paint displayed hardly any luminosity excepting when under blue glass. This proves

that it is the actinic rays, as in photography, which affect the paint. Red rays, indeed, destroy the light, but it was shown that this is due to the heat developed over-stimulating and exhausting it. A can of hot water had the same effect as red rays of light. Exposure to air or water does not affect the paint, and a painted model life-buoy was shown which, when placed in a jar of water, retained its brightness. The lecturer stated that the paint was efficiently bright in the dark until from eight to ten hours after the time when it had been exposed to light. He illustrated its practical utility in various ways, one illustration being a diver who walked into the darkened room with his dress covered with the paint, which gave him a very phantom-like appearance. It was mentioned that at Southampton Docks the divers had found the emitted light to be of much service under water. Professor Huxley, who presided, complimented the lecturer for his lucid explanation of the scientific as well as practical character of the paint. Mr. Balmain, he said, had been his intimate friend, and his name was remembered by all who knew him with veneration and affection. All felt his untimely death just at the moment when his patient researches commenced to bear fruit. In the discussion which followed it was suggested that a good use for the paint would be to paint shop-window shutters and street vehicles with it. Two railway companies had experimented with it for painting carriages running through tunnels, and these experiments had been very favour-

able. A vote of thanks was passed to Professor Heiton for his lecture.

A New Planetarium.—The old-fashioned orreries, which were constructed to show the arrangement of the solar system and the motions of the planets around the sun, were somewhat rude in their mechanism, and were apt to mislead from the conspicuousness of the rods and wires by which the astronomical movements were imitated.

Signor N. Perini, an Italian long domiciled in London, and whose name is well known as a successful teacher for the Civil Service and the Army, has invented a new planetarium which is free from most of the defects of its predecessors.

A high circular chamber or box, standing on twelve wooden pillars, is erected in the midst of an ordinary-sized room, with a ceiling higher than usual. On entering underneath this chamber and looking up, a dome is seen, deep blue, and sprinkled with stars. The chief northern constellations are in their proper places, and round the base of the dome are the names of the signs of the zodiac.

Suspended from the top of the dome by a narrow tube is an opal globe, lit inside with gas, and representing the sun. From wires almost invisible the planets are suspended around the sun, of sizes and at distances approximately proportionate to the real sizes and distances, and each having the proper inclination to the plane of its orbit. The various moons are in their places, and Saturn has his rings.

Thus far, however, all these miniature celestial bodies have been in a state of quiescence. Presently Signor Perini, by simply turning a key, sets the solar system in motion, slowly or swiftly, as he pleases. The sun turns on his axis, and the planets revolve around the sun in proper elliptical orbits, which are traced around the inside of the dome, which is 14 feet in diameter at its base and 14 feet high. By an ingenious watchwork arrangement inside the earth, which is the size of a walnut, our world is made to revolve on its axis, which latter always points to the same quarter of the heavens. In like manner the moon goes round the earth.

The machinery is arranged in the chamber above the dome, clock-work being the motive power, the originality in the arrangement being the method by which the inventor effects the elliptical motion of the planets. Not a sound is heard, the machinery works, like its great prototype, in solemn silence.

Signor Perini, who has been prompted to this work solely from the enthusiasm of a mechanician, has devoted his nights and mornings to this structure for seven years, and has spent on it about £700. The earth alone cost £40. The planetarium can be made of any size, from the dome of St. Paul's to a little thing that might be used for school instruction.

Mental Imagery.—During the sitting of the British Association at Swansea, an address was delivered, in the Music Hall, by Francis Galton, F.R.S., on "Mental Imagery," of which the following is an abstract :—

There is a true kinship between actual vision and the mental picture by which we recollect what we have seen. When light falls on the eye, a stimulus from without travels inwards towards the brain, where it associates itself with other waves of irritation proceeding from independent centres. In the formation of a mental picture the process is reversed. The action of the brain is propagated outwards, becoming fainter as it travels. The same nervous chain is concerned in both cases, but its links are differently affected. We may define Shakespeare's phrase of seeing with the "mind's eye" as a condition in which activity of the nervous centre bears a higher ratio to that of the nervous terminations than it does in ordinary vision.

The object of the lecturer was to point out the chief peculiarities in the mental imagery of different persons, to show that they were natural and hereditary and characteristic of different races, but that they admitted in a high degree of being developed by education, and to describe the most useful peculiarities for technical and artistic use as well as for philosophical generalisations. The medium characteristic of Mental Imagery among Englishmen was fairly vivid but incomplete. The field of their mental view was narrow, but by moving the mental eye from point to point the whole of the image could be successively seen, so far as it was remembered at all. He based these conclusions on hundreds of replies sent to an elaborate series of questions, of the substantial truth of which he was assured by frequent cross-

examinations. He found that the power of seeing an image vividly was by no means uncommon, so it was *a priori* reasonable to expect that education might develop the power of the large majority to that high level. In actual proof of this he quoted the experiences of M. Lecoq de Boisbaudran (*Enseignement Artistique*, Morel et Cie., Paris), the late director of the Ecole Nationale de Dessein, in Paris, to show how well the visualising faculty could be taught. His pupils were made to study simple models carefully and then to draw them from memory, and in a few months they had no difficulty in summoning the required images, in holding them steadily, and in drawing them. A commission of the Institute, appointed in 1852 to inquire into the results, reported most highly in their favour. M. Legros, the present Slade Professor of Fine Arts at University College, was one of M. Boisbaudran's pupils.

A description was given of many peculiarities of mental imagery, such as the strange and durable association in the minds of some persons with colours and letters or with days of the week, and the curious tendency of about one person in every 30 to visualise numerals in definite forms, which the lecturer recently described at the Anthropological Institute. These are examples of a want of flexibility in mental imagery that is characteristic of those who can with difficulty see an object mentally in more than one or two aspects. There are, for instance, many who cannot recall the faces of dear relations who have died, though those of persons

who are indifferent to them are easily recollected. This is chiefly owing to their seeing familiar faces very often in many aspects, and to the memories confusing one another. Philosophers who deal in abstract ideas avoid concrete representations and suppress mental imagery, and often lose the visualising faculty by disuse. But those whose mental imagery can be educated so as not to be hard and persistent in its character, abandon a great deal of much value to them by the disuse of this power. They lose the only means they have of creating a mental generic picture under the conditions explained by the lecturer last year at the Royal Institution, and as illustrated by his plan of composite portraiture, of which he exhibited specimens.

After giving details of various and not uncommon peculiarities, he stated, as a not unattainable ideal by the majority, that we should aim at the following result:—The power of calling up at will a clear and complete image of any object we have studied, and to be able to see it from any desired aspect, to construct clear images from description, and to alter them as we please; to create generic images from several different but somewhat similar elements, and to carry away pictures at a glance more complicated than we could analyse at the moment of seeing them.

The lecture was illustrated by specimens of the "visualised numerals," some simple, some shaded, and others coloured. He showed the practical application of his method of "statistics by inter-comparison" in obtaining

median, quartile, octile, and sub-octile values for the vividness of mental imagery. He also exhibited specimens of aboriginal work by the bushmen of South Africa, from the fine collection of Mr. Stow, who has very lately sent some specimens to England, in hopes that means might be found for the publication of the whole of them. Also from Esquimaux and their kinsmen, the ancient cave-dwellers. All these testified, as he showed, to a race-peculiarity of mental imagery, which was probable enough, as the tendency to visualise clearly was a natural gift, and he had found it to be hereditary in an exceptionally high degree.

From among the many evidences of the power of the Esquimaux to carry a mental image of a large extent of country, he exhibited a fac-simile of an aboriginal map, one of many contained in Hall's "Journals," published last year by the United States Government. It was the chart of a complicated coast-line, extending nearly 1,000 nautical miles in a direct line, over which the man had canoeed during his life, and it was drawn from memory alone. It might be compared to a chart of the south coast of England, the whole of those of France and Spain, and of the opposite shore of Italy. By the side of this was shown the Admiralty chart of 1874 of the same region, and the general coincidence between the two was striking. There was to his knowledge no instance among the many route maps compiled up to very recent years by travellers, totally unprovided with instruments, in Africa, Asia, and Aus-

tralia, of any that were comparable in extent and accuracy to that of this barbarous Esquimaux.

The visualising faculty was of importance in every trade or profession where design is required, because the workman ought to have a clear mental image of what he intends to do before he takes a tool in hand. The pleasure its use can afford is very great, many correspondents saying that the delight of recalling beautiful scenery and great works of art is the highest they know. A faculty that is of importance in all technical and artistic occupations, that gives accuracy to our perceptions and justness to our generalisations, is ignorantly starved by disuse instead of being cultivated in the way that will bring the best return.

Mr. Proctor on Meteors.—News comes from Missouri that a man has been killed there by the downfall of a meteoric mass. It is described as about as large as a bucket, and resembling iron pyrites. It cut its way through the branches of a maple tree as clean as a cannon ball could have done, struck and killed the man, and then buried itself 2ft. in the ground. At first, many supposed the account to be a cleverly-invented story of the great gooseberry type, but it has been confirmed, according to Mr. R. A. Proctor, in the *Newcastle Weekly Chronicle*. The chance of a death occurring in any given year by meteoric downfall is small, but not so exceedingly small as many imagine. It could readily be calculated if we knew the average number of meteorites, large enough to break their way through

the protecting armour of the air, which fall each year upon the earth. We may fairly assume that each human being (including all ages) presents an average surface towards the meteoric missiles of about one quarter of a square yard. (We must, of course, take into account the circumstance that meteors do not fall vertically; nor are all men all the time afoot.) Assuming the number of human beings in the world at each instant to be about 3,000,000,000, the space thus occupied by the human race as a whole would be one quarter of 3,000,000,000 of square yards. It will presently be seen why I leave the result in this form. Now the earth's surface contains 200,000,000 of square miles, each containing (nearly enough for such a calculation as this) 3,000,000 of square yards. Hence the surface of the earth contains 200,000 times 3,000,000,000 of square yards, whereas the human race covers but one quarter of 3,000,000,000 of square yards. So that the human race occupies but 1-800th part of the earth's surface. Therefore, if 2,000 meteorites annually reach the surface of the earth, the chances are but as 1 in 400 that one of these will kill a human being. On the average one human being would be killed in 400 years. It is worthy of notice, however, that if Professor Newton, of Yale College, is right in asserting that 400,000,000 of meteors of all orders, down to those visible only in a telescope, fall each year, the chances of death from meteoric downfall would be very great were it not for the efficient protection afforded by

our air. For in that case, as 400,000,000 exceeds 800,000 five hundred times, we might expect that on the average 500 persons would be killed each year. For the smallest meteor, travelling with planetary velocity, or many times faster than a cannon ball, would unquestionably be able to deal a fatal stroke. Fortunately there is no risk from these smaller meteors, for they are all vaporised in their rush through the air.

On the Darwinian Theory.—In the Department of Anatomy and Physiology of the British Association, the address was delivered by Mr. F. M. Balfour, F.R.S., one of the vice-presidents of the section, who observed that in the spring of the present year Professor Huxley delivered an address at the Royal Institution, to which he gave the felicitous title of "The Coming of Age of the Origin of Species." It was, as Professor Huxley pointed out, 21 years since Mr. Darwin's great work was published, and the present occasion, Mr. Balfour remarked, was an appropriate one to review the effect which it had had on the progress of biological knowledge. There was, he might venture to say, no department of biology the growth of which has not been profoundly influenced by the Darwinian theory.

When Messrs. Darwin and Wallace first enunciated their views to the scientific world, the facts they brought forward seemed to many naturalists insufficient to substantiate their far-reaching conclusions. Since that time an overwhelming mass of evidence has, however, been rapidly accu-

mulating in their favour. Facts which at first appeared to be opposed to their theories have one by one been shown to afford striking proofs of their truth. There are at the present time but few naturalists who do not accept in the main the Darwinian theory, and even some of those who reject many of Darwin's explanations still accept the fundamental position, that all animals are descended from the common stock.

To attempt in the time at his disposal to trace the influence of the Darwinian theory on all the branches of anatomy and physiology would be wholly impossible, and he would confine himself to an attempt to do so for a small section only. There was, perhaps, no department of biology which had been so revolutionised by the theory of animal evolution as that of development or embryology. The reason of this is not far to seek. According to the Darwinian theory, the present order of the organic world has been caused by the action of two laws, known as the laws of heredity and of variation.

The law of heredity is familiarly exemplified by the well-known fact that offspring resemble their parents. Not only, however, do the offspring belong to the same species as their parents, but they inherit the individual peculiarities of their parents. It is on this that the breeders of cattle depend, and it is a fact of everyday experience amongst ourselves. A further point with reference to heredity to which he must call their attention was the fact that the characteristics which display themselves at some special period

in the life of the parent are acquired by the offspring at a corresponding period. Thus, in many birds the males have a special plumage in the adult state. The male offspring is not, however, born with the adult plumage, but only acquires it when it becomes adult.

The law of variation is in a certain sense opposed to the law of heredity. It asserts that the resemblance which offspring bear to their parents is never exact. The contradiction between the two laws is only apparent. All variations and modifications in an organism are directly or indirectly due to its environments; that is to say, they are rather produced by some direct influence acting upon the organism itself, or by some more subtle and mysterious action on its parents; and the law of heredity really asserts that the offspring and parent would resemble each other if their environments were the same. Since, however, this is never the case, the offspring always differ to some extent from the parents. Now, according to the law of heredity, every acquired variation tends to be inherited, so that, by a summation of small changes, the animals may come to differ from their parent stock to an indefinite extent.

Mr. Balfour then referred to what he spoke of as a concrete example of the application of these two laws, his object being to demonstrate how completely modern embryological naming is dependent on inheritance and variation, which constitute the keystones of the Darwinian theory. He maintained that "The Origin of

Species" afforded explanations of important embryological facts, and added that no explanation, for instance, could be offered of why it is that a frog in the course of its growth has a stage in which it breathes like a fish, and then why it is like a newt with a long tail, which gradually becomes absorbed, and finally disappears.

To the Darwinian the explanation of such facts is obvious. The stage when the tadpole breathes by gills is a repetition of the stage when the ancestors of the frog had not advanced in the scale of development beyond a fish, while the newt-like stage implies that the ancestors of the frog were at one time organised very much like the newts of to-day. The explanation of such facts has opened out to the embryologist quite a new series of problems.

Having examined these in regard to phylogeny and organogeny and entering into elaborate scientific details and arguments, Mr. Balfour concluded by remarking that although the present state of our knowledge on the genesis of the nervous system is a great advance on that of a few years ago, there is still much remaining to be done to make it complete. The subject, he urged, was well worth the attention of the morphologist, the physiologist, or even the psychologist, and we must not remain satisfied by filling up the gaps in our knowledge by such hypotheses as he had been compelled to frame. New methods of research will probably be required to grapple with the problems that are still unsolved; but when we look back and survey what has been done in the past,

there can be no reason for mis-trusting our advance in the future.

The Mondolot Soda-water Machine.—This is an ingenious combination of the advantages of machines at present in use, without their disadvantages. Its distinctive features are: 1. Direct action.—The gas passes direct from the generator through the purifiers and pump, into the condenser. 2. Automatic action.—The gas is generated by a self-acting arrangement, at the exact rate at which it is drawn into and utilised in the condenser. By a very simple and ingenious arrangement the processes of generation, purification, and blending of the carbonic acid gas with the water, are all equal and coincident with each other, this being the necessary result of automatic action. The obvious and intrinsic merits of the Mondolot apparatus have led to its extensive adoption in this country and abroad, and no doubt it possesses advantages over all other machines hitherto introduced to the public.

The Nature and Uses of Museums.—The address in the Biological Section of the British Association, was delivered by Dr. A. C. G. Gunther, M.A., F.R.S., who took for his subject the "Nature and Uses of Museums." In the course of his address he said:—The purposes for which museums are formed are three-fold:—(1) To diffuse instruction among, and offer rational amusement to, the mass of the people; (2) To aid in the elementary study of biology; and (3) To supply the professed student of biology, or the specialist, with as complete

materials for his scientific researches as can be obtained, and to preserve for future generations the materials on which those researches have been based.

Although every museum has, as it were, a physiognomy of its own, differing from the others in the degree in which it fulfils one, two, or all three of those objects, we may divide museums into three classes, viz. :—(1) National ; (2) Provincial ; and (3) Strictly Educational museums—a mode of division which may give to those of this assembly who are not biologists an idea of what we mean by the term “species.” The three kinds pass into each other, and there may be hybrids between them. The museum of the third class, the Strictly Educational institution, we find established chiefly in connection with universities, colleges, medical and science schools. Its principal object is to supply the materials for teaching and studying the elements and general outlines of biology ; it supplements, and is the most necessary help, for oral and practical instruction, which always ought to be combined with this kind of museum.

The principal aim of a Provincial Museum ought, in my opinion, to be popular instruction. I do not mean that it should be merely a place for mild amusement and recreation, but that it should rank equal with all similar institutions destined to spread knowledge and cultivate taste among the people. To attain this aim it should contain an arranged series of well-preserved specimens, representing as many of the remarkable types of living forms as

are obtainable ; a series of useful as well as noxious plants and animals ; of economic products derived from the animal and vegetable kingdoms ; and last, but not least, a complete and accurately-named series of the flora and fauna of the neighbourhood. The majority of provincial museums with which I am acquainted are far from coming up to this ideal.

However great, however large a country or a nation may be, it can have, in reality, only one National Museum truly deserving of the name. Yours is the British Museum ; those of Scotland and Ireland can never reach the same degree of completeness, though there is no one who wishes more heartily than I do that they may approach it as closely as conditions permit.

The most prominent events in the recent history of the British Museum (to which I must confine the remainder of my remarks) are well known to the majority of those present :—that the question either of enlarging the present building at Bloomsbury, or of erecting another at South Kensington, for the collections of natural history, was fully discussed for years in its various aspects ; that, finally, a Select Committee of the House of Commons reported in favour of the expediency of the former plan ; that the Standing Committee of the Trustees, than whom there is no one better qualified to give an opinion, took the same view ; and that, nevertheless, the Government of the time decided upon severing the collections and locating the natural history in a separate building as the more economical

plan. The building was finished this year at a cost of £400,000, exclusive of the amount paid for the ground on which it is erected. And there is no doubt that it fulfils the principal condition for which it was erected, viz., space for the collections.

The zoological collections gain more than twice as much space as they had in the old building, the geological and mineralogical about thrice, and the botanical more than four times. It has been long understood that the exhibition of all the species, or even the majority of them, is a mistake, and that, therefore, two series of specimens should be formed, viz., one for the purposes of advanced scientific study, the study series; and the other comprising specimens illustrative of the leading points both of popular and scientific interest, this latter—the exhibition series—being intended to supply the requirements of the beginner in the study of natural history, and of the public.

Probably all of those present are aware that the formation of a natural history library has been urged almost from the very first day on which the removal of the natural history collections to South Kensington was proposed. But the cost and extent of such a library have been very variously estimated. And I am sorry to say that it is, I believe, owing to expressions of opinion on the part of those who ought to know better, that the cost of this library was considerably underrated when the removal to South Kensington was determined upon.

With the aid of some of my friends who know, from their daily occupation, the market value of natural history works, I made a calculation some years ago, and we came to the conclusion that a complete natural history library will cost £70,000, and, unpalatable as this statement may be to those who have advocated the removal of the natural history collections, and therefore must be held responsible for this concomitant expense, it will be found to be true. It will be satisfactory to you to learn that the Government have at last sanctioned the expenditure of half that amount.

Now, in my opinion, such a library formed in connection with the national museum should not be reserved for the use of the officials, but I would recommend that it should be accessible to the general class of students in the same manner as any other part of the collections. It is for this reason that I wish to see it rendered as perfect as possible with respect to the older publications (many of which are getting scarcer year by year) as well as to the most recent. If the British Museum (for the collections will remain united under this old time-honoured name, though locally separated) continues to receive that support from the Government to which it is justly entitled, I have no doubt that it will not only fulfil all the aims of a national collection, but that it will be also able to give to the kindred provincial institutions the aid which has recently been claimed on their behalf.

XII.—THE BRITISH ASSOCIATION. PRESIDENT'S ADDRESS.

*Delivered by Dr. ANDREW C. RAMSAY, F.R.S., at Swansea, on the
25th of August, 1880.*

On the Recurrence of Certain Phenomena in Geological Time.

In this address I propose to consider the recurrence of the same kind of incidents throughout all geological time, as exhibited in the various formations and groups of formations that now form the known parts of the external crust of the earth. This kind of investigation has for many years forced itself on my attention, and the method I adopt has not heretofore been attempted in all its branches. In olden times, Hutton and Playfair, in a broad and general manner, clearly pointed the way to the doctrine of uniformity of action and results throughout all known geological epochs down to the present day; but after a time, like the prophets of old, they obtained but slight attention, and were almost forgotten, and the wilder cosmical theories of Werner more generally ruled the opinions of the geologists of the time. Later still,

Lyell followed in the steps of Playfair, with all the advantages that the discoveries of William Smith afforded, and aided by the labours of that band of distinguished geologists, Sedgwick,

Buckland, Mantell, De la Beche, Murchison, and others, all of whom some of us knew. Notwithstanding this new light, even now there still lingers the relics of the belief (which some of these geologists also maintained), that the physical phenomena which produced the older strata were not only different in kind, but also in degree, from those which now rule the external world. Oceans, the waters of which attained a high temperature, attended the formation of the primitive crystalline rocks. Volcanic eruptions, with which those of modern times are comparatively insignificant, the sudden upheaval of great mountain chains, the far more rapid decomposition and degradation of rocks, and, as a consequence, the more rapid deposition of strata formed from their waste—all these were assumed as certainties, and still linger in some parts of the world among living geologists of deservedly high reputation.

The chief object of this address is, therefore, to attempt to show that whatever may have been the state of the world long before geological history began, as now written in the rocks, all known

formations are comparatively so recent in geological time, that there is no reason to believe that they were produced under physical circumstances differing either in kind or degree from those with which we are now more or less familiar.

It is unnecessary for my present purpose to enter into details connected with the recurrence of marine formations, since all geologists know that the greater part of the stratified rocks were deposited in the sea, as proved by the molluscs and other fossils which they contain, and the order of their deposition and the occasional stratigraphical breaks in succession are also familiar subjects. What I have partly to deal with now are exceptions to true marine stratified formations, and after some other important questions have been considered, I will proceed to discuss the origin of various non-marine deposits from nearly the earliest known time down to what by comparison may almost be termed the present day.

Metamorphism.

All, or nearly all, stratified formations have been in a sense metamorphosed, since, excepting certain limestones, the fact of loose incoherent sentiments having been by pressure and other agencies turned into solid rocks constitutes a kind of metamorphism. This, however, is only a first step toward the kind of metamorphism, the frequent recurrence of which in geological time I have now to insist upon, and which implies that consolidated strata have undergone subsequent changes of a kind much more remarkable.

Common stratified rocks chiefly consist of marls, shales, slates, sandstones, conglomerates, and limestones, generally distinct and definite; but not infrequently a stratum, or strata, may partake of the characters in varied proportions of two or more of the above-named species. It is from such strata that metamorphic rocks have been produced, exclusive of the metamorphism of igneous rocks, on which I will not enter. These may be looked for in every manual of geology, and usually they may be found in them.

As a general rule, metamorphic rocks are apt to be much contorted, not only on a large scale, but also that the individual layers of mica, quartz, and felspar in gneiss are bent and folded in a great number of minute convulsions, so small that they may be counted by the hundred in a foot or two of rock. Such metamorphic rocks are often associated with masses of granite, both in bosses and in interstratified beds or layers, and where the metamorphism becomes extreme it is often impossible to draw a boundary line between the gneiss and the granite; while, on the other hand, it is often impossible to draw any true boundary between gneiss (or other metamorphic rocks) and the ordinary strata that have undergone metamorphism. Under those circumstances, it is not surprising that, when chemically analysed, there is often little difference in the constituents of the unmetamorphosed and the metamorphosed rock. This is a point of some importance in relation to the origin and non-primitive

character of gneiss and other varieties of foliated strata, and also of some quartzites and crystalline limestones. I am aware that in North America formations consisting of metamorphic rocks have been stated to exist of older date than the Laurentian gneiss, and under any circumstances it is obvious that vast tracts of pre-Laurentian land must have existed in all regions, by the degradation of which sediments were derived wherewith to provide materials for the deposition of the originally unaltered Laurentian strata.

In England, Wales, and Scotland, attempts have also been made to prove the presence of more ancient formations, but I do not consider the data provided sufficient to warrant any such conclusion. In the Highlands of Scotland, and in some of the Western Isles, there are gneissic rocks of pre-Cambrian age, which, since they were first described by Sir Roderick Murchison in the North-west Highlands, have been, I think justly, considered to belong to the Laurentian series, unconformably underlying Cambrian and Lower Silurian rocks, and as yet there are no sufficient grounds for dissenting from his conclusion that they form the oldest known rocks in the British Islands.

It is unnecessary here to discuss the theory of the causes that produced the metamorphism of stratified rocks, and it may be sufficient to say that under the influence of deep underground heat, aided by moisture, sandstones have been converted into quartzites, limestones have be-

come crystalline, and in shaly, slaty, and schistose rocks, under like circumstances, there is little or no development of new material, but rather, in the main, a rearrangement of constituents according to their chemical affinities in rudely crystalline layers, which have very often been more or less developed in pre-existing planes of bedding. The materials of the whole are approximately the same as those of the unaltered rock, but have been arranged in layers, for example, of quartz, felspar, and mica, or of hornblende, &c., while other minerals, such as schorl and garnets, are of not infrequent occurrence. It has for years been an established fact that nearly the whole of the mountain masses of the Highlands of Scotland (exclusive of the Laurentian, Cambrian, and Old Red Sandstone formations), mostly consist of gneissic rocks of many varieties, and of quartzites and a few bands of crystalline limestone, which, from the north shore to the edge of the Old Red Sandstone, are repeated again and again in stratigraphical convolutions great and small. Many large bosses, veins, and dykes, or granite, are associated with these rocks, and, as already stated, it sometimes happens that it is hard to draw a geological line between granite and gneiss and *vice versa*.

These rocks, once called Primary or Primitive, were first proved by Sir Roderick Murchison to be of Lower Silurian age, thus revolutionising the geology of nearly one-half of Scotland. To the same age belongs by far the greater part of the broad hilly region of the south of Scotland

that lies between St. Abb's Head on the east and the coast of Ayrshire and Wigtonshire on the west. In the south-west part of this district, several great masses of granite rise amid the Lower Silurian rock, which in their neighbourhood pass into mica-schist and even into fine grained gneiss. In Cornwall the occurrence of Silurian rocks is now well known. They are of metamorphic character, and partly associated with granite; and at Start Point, in South Devonshire, the Silurian strata have been metamorphosed into quartzites. In parts of the Cambrian areas, Silurian rocks in contact with granite have been changed into crystalline hornblendic gneiss, and in Anglesea there are large tracts of presumed Cambrian strata, great part of which have been metamorphosed into chlorite and mica-schist and gneiss, and the same is partly the case with the Lower Silurian rocks of the centre of the island, where it is almost impossible to disentangle them from the associated granite.

In Ireland similar metamorphic rocks are common, and, on the authority of Professor Hull, who knows them well, the following statements are founded:—"Metamorphism in Ireland has been geographical and not stratigraphical, and seems to have ceased before the Upper Silurian period. The epoch of greatest metamorphism appears to have been that which intervened between the close of the Lower Silurian period and the commencement of the Upper Silurian, taking the formations in ascending order. It is as yet un-

decided whether Laurentian rocks occur in Ireland. There are rocks in North-west Mayo very like those in Sutherlandshire, but if they are of Laurentian age they come directly under the metamorphosed Lower Silurian rocks, and it may be very difficult to separate them. Cambrian purple and green grits are not metamorphosed in the counties of Wicklow and Dublin, but the same beds at the southern extremity of County Wexford, near Carnsore Point, have been metamorphosed into mica-schist and gneiss. In the east of Ireland the Lower Silurian grits and slates have not been metamorphosed, except where in proximity to granite, into which they insensibly pass in the counties of Wicklow, Dublin, Westmeath, Cavan, Longford, and Down; but in the west and north-west of Ireland they have been metamorphosed into several varieties of schists, hornblende rock, and gneiss, or foliated granite."

It would be easy to multiply cases of the metamorphism of Silurian rocks on the continent of Europe, as, for example, in Scandinavia, and in the Ural Mountains, where, according to Murchison, "by following its masses upon their strike, we are assured that the same zone which in one tract has a mechanical aspect and is fossiliferous, graduates in another parallel of latitude into a metamorphic crystalline condition, whereby not only the organic remains, but even the original impress of sedimentary origin are to a great degree obliterated." The same kind of phenomena are common in Canada

and the United States; and Medlicott and Blanford, in "The Geology of India," have described the thorough metamorphism of Lower Silurian strata into gneiss and syenitic and hornblende schists. In Britain, none of the Upper Silurian rocks have undergone any serious change beyond that of ordinary consolidation, but in the Eastern Alps at Gratz, Sir Roderick Murchison has described both Upper Silurian and Devonian strata interstratified with separate courses of metamorphic chloritic schist.

Enough has now been said to prove the frequent occurrence of metamorphic action among Cambrian and Lower and Upper Silurian strata. If we now turn to the Devonian and Old Red Sandstone strata of England and Scotland, we find that metamorphic action has also been at work, but in a much smaller degree. In Cornwall and Devon, five great bosses of granite stand out amid the stratified Silurian, Devonian, and Carboniferous formations. Adjoining or near these bosses the late Sir Henry De la Beche remarks, that "in numerous localities we find the coarser slates converted into rocks resembling mica-slate and gneiss, a fact particularly well exhibited in the neighbourhood of Meavy, on the south-east of Tavistock," and "near Camelford we observed a fine arenaceous and micaceous grauwacke turned into a rock resembling mica-slate near the granite." Other cases are given by the same author, of slaty strata turned into mica-schist and gneiss in rocks now generally considered to be of Devonian age. The De-

vonian rocks and Old Red Sandstone are of the same geological age, though they were deposited under different conditions, the first being of marine, and the latter of fresh-water origin.

The Old Red Sandstone of Wales, England, and Scotland has not, as far as I know, suffered any metamorphism, excepting in one case, in the north-east of Ayrshire, near the sources of the Avon Water, where a large boss of granite rises through the sandstone, which all round has been rendered crystalline with well-developed crystals of felspar. On the continent of Europe, a broad area of Devonian strata lies on both banks of the Rhine and the Moselle. Forty years ago, Sedgwick and Murchison described the crystalline quartzites, chlorite, and micaceous schists of the Hunsrück and the Taunus, and from personal observation I know that the rocks in the country on either side of the Moselle are, in places, of a foliated or semi-foliated metamorphic character.

In the Alps also, as already noticed, metamorphic Devonian strata occur interstratified with beds of metamorphic schists, and, Sir Roderick adds, "we have ample data to affirm that large portions of the Eastern Alps . . . are occupied by rocks of true Palæozoic age, which in many parts have passed into a crystalline state." I know of no case in Britain where the carboniferous strata have been thoroughly metamorphosed, excepting that in South Wales, beds of coal, in the west of Carmarthenshire and in South Pembrokeshire, gradually pass from so-called bituminous

coal into anthracite. The same is the case in the United States, in both instances the carboniferous strata being exceedingly disturbed and contorted. In the Alps, however, Sir Roderick Murchison seems to have believed that carboniferous rocks may have been metamorphosed : a circumstance since undoubtedly proved by the occurrence of a coal-measure calomite, well preserved, but otherwise partaking of the thoroughly crystalline character of the gneiss in which it is imbedded, and which was shown to me by the late Professor Gastaldi, at Turin. I am well acquainted with all the Permian strata of the British Islands and of various parts of continental Europe, and nowhere, that I have seen, have they suffered from metamorphic action, and strata of this age are, I believe, as yet unknown in the Alps. This closes the list of metamorphism of Palaeozoic strata.

I will not attempt (they are so numerous) to mention all the regions of the world in which Mesozoic or Secondary formations have undergone metamorphic action. In Britain and the non-mountainous parts of France, they are generally quite altered, but in the Alps it is different. There, as every one knows who is familiar with that region, the crystalline rocks in the middle of the chain have the same general strike as the various flanking stratified formations. As expressed by Murchison, "as we follow the chain from N.E. to S.W. we pass from the clearest types of sedimentary rocks, and at length, in the Savoy Alps, are immersed in the highly altered mountains of

secondary limestone," while "the metamorphism of the rocks is greatest as we approach the centre of the chain"; and, indeed, any one familiar with the Alps of Switzerland and Savoy knows that a process of metamorphism has been undergone by *all the Jurassic rocks* (lias and oolites) of the great mountain chain.

Whether or not any strata of Neocomian and Cretaceous age have been well metamorphosed in this region I am unable to say; but it seems to be certain that the Eocene or Lower Tertiary Alpine formations, known as the Flysch, contains beds of black schists which pass into Lydian stone, and also that in the Grisons it has been converted into gneiss and mica-schist, a fact mentioned by Studer and Murchison. I also have seen in the country north of the Oldenhorn, Nummulitic rocks so far foliated that they formed an imperfect gneiss. In Tierra del Fuego, as described by Darwin, clay slates of early cretaceous date pass into gneiss and mica-slate with garnets, and in Chonos Islands, and all along the great Cordillera of the Andes of Chili, rocks of Cretaceous or Cretaceo-oolitic age have been metamorphosed into foliated mica-slate and gneiss, accompanied by the presence of granite, syenite, and greenstone.

This ends my list, for I have never seen, or heard, of metamorphic rocks of later date than those that belong to the Eocene series. Enough, however, has been said to prove that, from the Laurentian epoch onward, the phenomenon of extreme metamorphism of strata has been of fre-

quent recurrence all through Palæozoic and Mesozoic times, and extends even to a part of the Eocene series equivalent to the soft unaltered strata of the formations of the London and Paris basins, which, excepting for their fossil contents, and sometimes highly-inclined positions, look as if they had only been recently deposited.

Volcanoes.

The oldest volcanic products of which I have personal knowledge are of Lower Silurian age. These in Wales consist of two distinct series, the oldest of which, chiefly formed of felspathic lavas and volcanic ashes, lie in and near the base of the Llandeilo beds, and the second, after a long interval of repose, were ejected and intermingled with the strata forming the middle part of the Bala beds. The Lower Silurian rocks of Montgomeryshire, Shropshire, Radnorshire, Pembrokeshire, Cumberland, and Westmoreland, are, to a great extent, also the result of volcanic eruptions, and the same kind of volcanic rocks occur in the Lower Silurian strata of Ireland. I know of no true volcanic rocks in the Upper Silurian series. In the Old Red Sandstone of Scotland lavas and volcanic ashes are of frequent occurrence, interstratified with the ordinary lacustrine sedimentary strata. Volcanic rocks are also intercalated among the Devonian strata of Devonshire. I know of none in America or on the continent of Europe. In Scotland volcanic products are common throughout nearly the whole of the Carboniferous sub-formations, and they

are found also associated with Permian strata.

I now come to the Mesozoic or Secondary epochs. Of Jurassic age (Lias and Oolites), it is stated by Lyell, with some doubt, that true volcanic products occur in the Morea and also in the Apennines, and it seems probable, as stated by Medlicott and Blanford, that the Rajmahal traps may also be of Jurassic age. In the Cordilleras of South America, Darwin has described a great series of volcanic rocks, intercalated among the Cretaceo-oolitic strata that forms so much of the chain ; and the same author, in his "Geological Observations in South America," states that the Cordillera has been, probably with some quiescent periods, a source of volcanic matter from an epoch anterior to our Cretaceo-oolitic formation to the present day. In the Deccan volcanic traps rest on Cretaceous beds, and are overlaid by Nummulitic strata ; and, according to Medlicott and Blanford, these were poured out in the interval between Middle Cretaceous and Lower Eocene times.

In Europe the only instance I know of a volcano of Eocene age is that of Monte Bolca, near Verona, where the volcanic products are associated with the fissile limestone of that area. The well-preserved relics of Miocene volcanoes are prevalent over many parts of Europe, such as Auvergne and The Velay, where the volcanic action began in Lower Miocene times, and was continued into the Pliocene epoch. The volcanoes of the Eifel are also of the same general age, together with the ancient Miocene vol-

canoes of Hungary. The volcanic rocks of the Azores, Canaries, and Madeira, are of Miocene age, while in Tuscany there are extinct volcanoes that began in late Miocene, and lasted into times contemporaneous with the English Coral-line Crag. In the north of Spain also, at Olot in Catalonia, there are perfect craters and cones remaining of volcanoes that began to act in newer Pliocene times, and continued in action to a later geological date. To these I must add the great *coulées* of Miocene lava, so well known in the Inner Hebrides, on the mainland near Oban, &c., in Antrim in the north of Ireland, in the Faroe Islands, Greenland, and Franz - Joseph Land.

It is needless, and would be tiresome, further to multiply instances, for enough has been said to show that in nearly all geological ages volcanoes have played an important part, now in one region, now in another, from very early Palæozoic times down to the present day ; and, as far as my knowledge extends, at no period of geological history is there any sign of their having played a more important part than they do in the epoch in which we live.

Mountain Chains.

The mountain chains of the world are of different geological ages, some of them of great antiquity, and some of them comparatively modern. It is well known that in North America the Lower Silurian rocks lie unconformably on Laurentian strata, and also that the latter had undergone a thorough metamorphism,

and been thrown into great anticlinal and synclinal folds, accompanied by intense minor convulsions, before the deposition of the oldest Silurian formation, that of the Potsdam Sandstone. Disturbances of the nature alluded to imply beyond a doubt that the Laurentian rocks formed a high mountain chain of pre-Silurian date, which has since constantly been worn away and degraded by sub-aerial denudation. In Shropshire and in parts of North Wales, and in Cumberland and Westmoreland, the Lower Silurian rocks by upheaval formed hilly land before the beginning of the Upper Silurian epoch ; and it is probable that the Lower Silurian gneiss of Scotland formed mountains at the same time, probably very much higher than now.

However that may be, it is certain that these mountains formed high land before and during the deposition of the Old Red Sandstone, and the upheaval of the great Scandinavian chain (of which the Highlands may be said to form an outlying portion) also preceded the deposition of the Old Red strata. In both of these mountain regions the rocks have since undergone considerable movements, which in the main seem to have been movements of elevation, accompanied undoubtedly by that constant atmospheric degradation to which all high land is especially subject. The next great European chain in point of age is that of the Ural, which according to Murchison is of pre-Permian age, a fact proved by the Permian conglomerates which were formed from the waste of the older strata. On these they lie

quite unconformably, and nearly undisturbed on the western flank of the mountains.

In North America the great chain of the Alleghany Mountains underwent several disturbances, the last (a great one) having taken place after the deposition of the Carboniferous rocks, and before that of the New Red Sandstone. The vast mountainous region included under the name of the Rocky Mountains, after several successive disturbances of upheaval, did not attain its present development till after the Miocene or Middle Tertiary epoch. In South America, notwithstanding many oscillations of level recorded by Darwin, the main great disturbance of the strata that form the chain of the Andes took place apparently in post-Cretaceous times.

The Alps, the rudiments of which began in more ancient times, received their greatest disturbance and upheaval in post-Eocene days, and were again raised at least 5,000 ft. (I believe much more) at the close of the Miocene epoch. The Apennines, the Pyrenees, the Carpathians, and the great mountain regions on the east of the Adriatic and southward into Greece, are of the same general age, and this is also the case in regard to the Atlas in North Africa, and the Caucasus on the borders of Europe and Asia. In the north of India the history of the Great Himalayan range closely coincides with that of the Alps, for while the most powerful known disturbance and elevation of the range took place after the close of the Eocene epoch, a subsequent elevation o-

curred in post-Miocene times, closely resembling and at least equal to that sustained by the Alps at the same period.

It would probably not be difficult by help of extra research to add other cases to this notice of recurrences of the upheaval and origin of special mountain chains, some of which I have spoken of from personal knowledge; but enough has been given to show the bearing of this question on the argument I have in view, namely, that of repetition of the same kind of events throughout all known geological time.

Salt and Salt Lakes.

I now come to the discussion of the circumstances that produced numerous recurrences of the development of beds of various salts (chiefly common rock-salt) in many formations, which it will be seen are to a great extent connected with continental or inland conditions. In comparatively rainless countries salts are often deposited on the surface of the ground by the effect of solar evaporation of moisture from the soil. Water dissolves certain salts in combination with the ingredients of the underlying rocks and salt, and brings it to the surface, and when solar evaporation ensues the salt or salts are deposited on the ground. This is well-known to be the case in and near the region of the Great Salt Lake in North America, and in South America, in some of the nearly rainless districts of the Cordillera, extensive surface deposits of salts of various kinds are common.

The surface of the ground

around the Dead Sea is also in extra-dry seasons covered with salt, the result of evaporation, and in the upper provinces of India (mentioned by Medlicott and Blanford) "many tracts of land in the Indo-Gangetic alluvial plain are rendered worthless for cultivation by an efflorescence of salt known in the north-west provinces as *Reh*" while every geographer knows that in central Asia, from the western shore of the Caspian Sea to the Kinshan Mountains of Mongolia, with rare exceptions, nearly every lake is salt in an area at least 3,500 miles in length. The circumstance is due to the fact that all so-called fresh water springs, and therefore all rivers, contain small quantities of salts in solution only appreciable to the chemist, and by the constant evaporation of pure water from the lakes, in the course of time it necessarily happens that these salts get concentrated in the water by the effect of solar heat, and, if not already begun, precipitation of solid salts must ensue.

The earliest deposits of rock-salt that I know about have been described by Mr. A. B. Wynne, of the Geological Survey of India, in his memoir "On the Geology of the Salt Range in the Punjab." The beds of salt are of great thickness, and along with gypsum and dolomitic layers occur in marl of a red colour, like our Keuper marl. This colour I have for many years considered to be in certain cases apt to indicate decomposition of sediments in inland lakes, salt or fresh, as the case may be, and with respect to these strata in the Punjab salt authors seem to be in doubt

whether they were formed in inland lakes or in lagoons near the seaboard, which at intervals were liable to be flooded by the sea, and in which, in the hot seasons, salts were deposited by evaporation caused by solar heat. For my argument, it matters but little which of these was the true physical condition of the land of the time, though I incline to think the inland lake theory most probable. The age of the strata associated with this salt is not yet certainly ascertained. In "The Geology of India" Medlicott and Blanford incline to consider them of Lower Silurian age, and Mr. Wynne, in his "Geology of the Salt Range," places the salt and gypsum beds doubtfully on the same geological horizon.

The next salt-bearing formation that I shall notice is the Salina or Onondaga salt group of North America, which forms part of the Upper Silurian rocks, and lies immediately above the Niagara limestone. It is rich in gypsum and in salt-brine, often of a very concentrated character, "which can only be derived from original depositions of salt," and it is also supposed by Dr. T. Sterry Hunt to contain solid rock-salt 115ft. in thickness at the depth of 2,085 feet, near Saginaw Bay in Michigan. In the Lower Devonian strata of Russia, near Lake Ilmen, Sir R. Murchison describes salt springs at Starai Russia. Sinkings "made in the hope of penetrating to the source of these salt springs" reached a depth of 600 feet without the discovery of rock salt, "and we are left in doubt whether the real source of

the Devonian rocks or even in the Silurian system." In the United States brine springs also occur in Ohio, Pennsylvania, and Virginia, in Devonian rocks. In Michigan salts are found from the Carboniferous down to the Devonian series; and in other parts of the United States, Western Pennsylvania, Virginia, Ohio, Illinois, and Kentucky, from the Lower Coal-measures salts are derived which must have been deposited in inland areas, since even in the depths of inland seas that communicate with the great ocean, such as the Mediterranean and the Red Sea, no great beds of salt can be deposited. Before such strata of salt can be formed, supersaturation must have taken place.

In the North of England, at and near Middlesbrough, two deep boreholes were made some years ago in the hope of reaching the coal-measures of the Durham coal-field. One of them at Salt-home was sunk to a depth of 1,355 feet. First they passed through 74 feet of superficial clay and gravel, next through about 1,175 feet of red sandstones and marls, with beds of rock salt and gypsum. The whole of these strata (excepting the clay and gravel) evidently belong to the Keuper marls and sandstones of the upper part of our New Red series. Beneath these they passed through 67 feet of dolomitic limestone, which in this neighbourhood forms the upper part of the Permian series, and beneath the limestone the strata consists of 27 feet of gypsum and rock-salt and marls, one of the beds of rock-salt having a thickness of

14 feet. This bed of Permian salt is of some importance, since I have been convinced for long that the British Permian strata were deposited, not in the sea, but in salt lakes comparable in some respects to the great salt lake of Utah, and in its restricted fauna to the far greater salt lake of the Caspian Sea. The gypsum, the dolomite or magnesian limestone, the red marls covered with rain-pittings, the sun-cracks, and the impressions of footprints of reptiles made in the soft sandy marls when the water was temporarily lowered by the solar evaporation of successive summers, all point to the fact that our Permian strata were not deposited in the sea, but in a salt lake or lakes once for a time connected with the sea. The same may be said of other Permian areas in the central parts of the continent of Europe, such as Stassfurt and Anhalt, Halle and Altern in Thuringia, and Sperenberg, near Berlin, and also in India. Neither do I think that the Permian strata of Russia, as described by Sir Roderick Murchison, were necessarily, as he implies, deposited in a wide ocean. According to his view, all marine life declined to a minimum after the close of the Carboniferous period, that decline beginning with the Permian and ending with the Triassic epoch.

Those who believe in the doctrine of evolution will find it hard to accept the idea which this implies, namely, that all the prolific forms of the Jurassic series sprang from the scanty faunas of the Permian and Triassic epochs. On the contrary, it seems to me

more rational to attribute the poverty of the faunas of these epochs to accidental abnormal conditions in certain areas, that for a time partially disappeared during the deposition of the Continental Muschelkalk, which is absent in the British Triassic series. In the whole of the Russian Permian strata only 53 species were known at the time of the publication of "Russia and the Ural Mountains," and I have not heard that this scanty list has been subsequently increased.

I am therefore inclined to believe that the red marls, grits, sandstones, conglomerates, and great masses of gypsum and rock-salt were all formed in a flat inland area, which was occasionally liable to be invaded by the sea during intermittent intervals of minor depression, sometimes in one area, sometimes in another, and the fauna small in size and poor in numbers is one of the results, while the deposition of beds of salt and gypsum is another. If so, then in the area now called Russia, in sheets of inland Permian water, deposits were formed strictly analogous to those of Central Europe and of Britain, but on a larger scale. Other deposits of salt deep beneath overlying younger strata are said to occur at Bromberg in Prussia, and many more might be named as lying in the same formation in northern Germany.

If we now turn to the Triassic series it is known that it consists of only two chief members in Britain, the Bunter Sandstones, and the Keuper or New Red Marls, the Muschelkalk of the Continent being absent in our

islands. No salt is found in the Bunter Sandstones of England, but it occurs in these strata at Schöningen in Brunswick and also near Hanover. In the lower part of the Keuper series deposits of rock-salt are common in England and Ireland. At Almersleben, near Calbe, rock-salt is found in the Muschelkalk, and also at Erfurt and Slottenheim in Thuringia, and at Wilhelmsglück, in Wurtemberg. In other Triassic areas it is known at Honigen, in Hanover, in middle Keuper beds. In the red shales at Sperenberg and Leith on the Lower Elbe, salt was found at the depth of 3,000ft., and at Stassfurt the salt is said to be "several hundred yards thick." In Central Spain rock-salt is known, and at Tarragona, Taen, and also at Santander in the north of Spain, all in Triassic strata. Other localities may be named in the Upper Trias, such as the Salzkammergut, Aussee, Ischl, Hallein in Salzburg, Halle in the Tyrol, and Berchesgaden in Bavaria.

In the Salt Range of mountains in Northern India saliferous strata are referred with some doubt by Medlicott and Blanford to the Triassic strata. In the Jurassic series (lias and oolites) salt and gypsum are uncommon.

One well-known instance occurs at Berg, in the valley of the Rhone in Switzerland, where salt is derived from the Lias. Salt and gypsum are also found in Jurassic rocks at Burgos in Spain. At Gap in France there is gypsum, and salt is found in the Austrian Alps in oolitic limestone. In the Cretaceous rocks

salt occurs, according to Lartet, at Jebel Usdom by the Dead Sea, and other authorities state that it occurs in the Pyrenees and at Biskra in Africa, where "mountains of salt" are mentioned as of Cretaceous age. The two last-named localities are possibly uncertain; but, whether or not this is the case, it is not the less certain that salt has been deposited in Cretaceous rocks, and, judging by analogy, probably in inland areas of that epoch. In the Eocene, or Older Tertiary formations, rock-salt is found at Cardona in Spain, and at Kohat in the Punjab it occurs at the base of Nummulitic beds. It is also known at Mandi in India in strata supposed to be of Nummulitic Eocene age.

The record does not end here, for a zone of rock-salt lies in Sicily at the top of the Salina clays in Lower Miocene beds, and in Miocene strata gypsum is found at several places in Spain, while salt also occurs in beds that are doubtfully of Miocene age (but may be later) at Wielitzka in Poland, Kalusz in Galicia, Bukowina, and also in Transylvania. In Pliocene or later Tertiary formations, thick beds of gypsum are known in Zante, and strata of salt occur in Roumania and Galicia, while in Pliocene rocks, according to Dana, or in Post-Tertiary beds, according to others, a thick bed of pure salt was penetrated to a depth of 38 feet at Petit Anse in Louisiana.

This ends my list, though, I have no doubt that, by further research, many more localities might be given. Enough, however, has been done to show that

rock-salt (and other salts) are of frequent recurrence throughout all geological time, and as in my opinion it is impossible that common salt can be deposited in the open ocean, it follows that this and other salts must have been precipitated from solutions which, by the effect of solar evaporation, became at length supersaturated, like those of the Dead Sea, the great salt lake of Utah, and in other places which it is superfluous to name.

Fresh-water Lakes and Estuaries.

I now come to the subject of recurrences of fresh-water conditions both in lakes and estuaries. In the introduction to the "Geology of India," by Messrs. Medlicott and Blanford, mention is made of the Blaini and Krol rocks as probably occupying "hollows formed by denudation in the old gneissic rocks," and the inference is drawn that "if this be a correct view, it is probable that the cis-Himalayan Palæozoic rocks are in great part of fresh-water origin, and that the present crystalline axis of the Western Himalayas approximately coincides with the shore of the ancient Palæozoic continent, of which the Indian peninsula formed a portion." The Krol rocks are classed broadly with "Permian and Carboniferous" deposits, but the Blaini beds are doubtfully considered to belong to upper Silurian strata. If this point be by-and-by established, this is the earliest known occurrence of fresh-water strata in any of the more ancient Palæozoic formations.

It is a fact worthy of notice that the colour of the strata

formed in old lakes (whether fresh or salt) of Palæozoic and Mesozoic age is apt to be red; a circumstance due to the fact that each little grain of sand or mud is usually coated with a very thin pellicle of peroxide of iron. Whether or not the red and purple Cambrian rocks may not be *partly* of fresh-water origin, is a question that I think no one but myself has raised. There is, however, in my opinion, no doubt with regard to the fresh-water origin of the Old Red Sandstone, as distinct from the contemporaneous marine deposits of the Devonian strata. This idea was first started by that distinguished geologist, Doctor Fleming, of Edinburgh, followed by Mr. Godwin-Austen, who, from the absence of marine shells, and the nature of the fossil fishes in these strata, inferred that they were deposited, not in the sea, as had always been asserted, but in a great fresh-water lake, or in a series of lakes.

In this opinion I have for many years agreed, for the nearest analogies of the fish are, according to Huxley, the *Polypterus* of African rivers, the *Ceratodus* of Australia, and in less degree the *Lepidosteus* of North America. The truth of the supposition that the Old Red Sandstone was deposited in fresh water is further borne out by the occurrence of a fresh-water shell, *Anodonta Jukessi*, and of ferns in the Upper Old Red Sandstone in Ireland; and the same shell is found at Dura Den in Scotland, while at Caithness, along with numerous fishes, there occurs the small bivalve crustacean *Easteria Murchisoniae*. I think it more than probable that the red series

of rocks that form the Catskill Mountains of North America (and with which I am personally acquainted) were formed in the same manner as the Old Red Sandstones of Britain; for, excepting in one or two minor interstratifications, they contain no relics of marine life, while "the fossil fishes of the Catskill beds, according to Dr. Newberry, appear to represent closely those of the British Old Red Sandstone." (Dana).

The Devonian rocks of Russia, according to the late Sir Roderick Murchison, consist of two distinct types, viz., Devonian strata identical in general character with those in Devonshire and in various parts of the continent of Europe. These are exclusively of a marine character, while the remainder corresponds to the Old Red Sandstone of Wales, England, and Scotland. At Tchudora, about 105 miles S.E. of St. Petersburg, the lowest members of the series consist of flag-like compact limestones accumulated in a tranquil sea, and containing fucoids and encrinites, together with shells of Devonian age, such as *Spirifera*, *Terebratula*, *Orthis*, *Leptena*, *Avicula*, *Modiola*, *Natica*, *Bellerophon*, &c., while the upper division graduates into the Carboniferous series as it often does in Britain, and like the Old Red Sandstone of Scotland, contains only fish-remains, and in both countries they are of the same species. "Proceeding from the Valdai Hills on the north," the geologist "quits a Devonian zone with a true 'Old Red' type dipping under the carboniferous rocks of Moscow, and having passed through the latter, he finds

himself suddenly in a yellow-coloured region, entirely dissimilar in structure to what he had seen in any of the northern governments, which, of a different type as regards fossils, is the true stratigraphical equivalent of the Old Red system." This seems to me, as regards the Russian strata, to mean that just as the Devonian strata of Devonshire are the true equivalents of the Old Red Sandstone of Wales and Scotland, they were deposited under very different conditions, the first in the sea, and the others in inland fresh-water lakes. At the time Sir Roderick Murchison's work was completed, the almost universal opinion was that the Old Red Sandstone was a marine formation.

In the year 1830, the Rev. Dr. Fleming, of Edinburgh, read a paper before the Wernerian Society, in which he boldly stated that the "Old Red Sandstone is a fresh-water formation" of older date than the carboniferous limestone. This statement, however, seems to have made no impression on geologists till it was revived by Mr. Godwin-Austen in a memoir "On the Extension of Coal-measures," &c., in the *Journal of the Geological Society*, 1856. Even this made no converts to what was then considered an heretical opinion. I have long held Dr. Fleming's view, and unfortunately published it in the third edition of "The Physical Geology and Geography of Great Britain," without at any time being aware that I had been fore-stalled by Dr. Fleming and Mr. Godwin-Austen.

To give anything like a detailed account of all the fresh-

water formations deposited in estuaries and lakes from the close of the Old Red Sandstone times down to late Tertiary epochs, is only fitted for a manual of geology, and would too much expand this address; and I will, therefore, give little more than a catalogue of these deposits in ascending order. In the coal-measure parts of the carboniferous series, a great proportion of the shales and sandstones are of fresh-water origin. This is proved all over the British Islands by the shells they contain, while here and there marine interstratifications occur, generally of no great thickness. There is no doubt among geologists that these coal-measure strata were chiefly deposited under estuarine conditions, and sometimes in lagoons or in lakes; while numerous beds of coal, formed by the life and death of land-plants, each underlaid by the soil on which the plants grew, evince the constant recurrence of terrestrial conditions. The same kind of phenomena are characteristic of the coal-measures all through North America, and in every country on the continent of Europe, from France and Spain on the west to Russia in the east, and the same is the case in China and in other areas.

In Scotland, according to Prof. Judd, fresh-water conditions occur more or less all through the Jurassic series, from the Lias to the Upper Oolites. In England, fresh-water strata, with thin beds of coal, are found in the Inferior Oolites of Yorkshire, and in the middle of England and elsewhere in the Great Oolite. The Pur-

beck and Wealden strata, which, in a sense, fill the interval between the Jurassic and Cretaceous series, are almost entirely formed of fresh-water strata, with occasional thin marine interstratifications. By some the Wealden beds are considered to have been formed in and near the estuary of a great river, while others, with as good a show of reason, believe them to have been deposited in a large lake subject to the occasional influx of the sea.

In the Eastern part of South Russia the Lias consists chiefly of fresh-water strata, as stated by Neumayr. The Godwano rocks of Central India range from Upper Palæozoic times well into the Jurassic strata, and there all these formations are of fresh-water origin. Fresh-water beds with shells are also interstratified with the Deccan traps of Cretaceous and Tertiary (Eocene) age, while 2,000ft. of fresh-water sands overlie them. In South-Western Sweden, as stated by Mr. Bauermaan, "the three coal-fields of Hoganas, Stabbarp, and Rodingé lie in the uppermost Triassic or Rhætic series." In Africa, the Karoo beds, which it is surmised may be of the age of the New Red Sandstone, contain beds of coal. In North America, certain fresh-water strata, with beds of lignite, apparently belong to the Cretaceous and Eocene epochs, and in the north of Spain and south of France there are fresh-water lacustrine formations in the highest Cretaceous strata. In England the lower and upper Eocene strata are chiefly of fresh-water origin, and the same is the case in France and other parts of

the Continent. Certain fresh-water formations in Central Spain extend from the Eocene to the upper Miocene strata. There is only one small patch of Miocene beds in England, at Bovey Tracey, near Dartmoor, formed of fresh-water deposits with interstratified beds of lignite or Miocene coal.

On the continent of Europe, Miocene strata occupy immense independent areas, extending from France and Spain to the Black Sea. In places too numerous to name, they contain beds of "brown coal," as lignite is sometimes called. These coal-beds are often of great thickness and solidity. In one of the pits which I descended, near Teplitz, in Bohemia, the coal, which lies in a true basin, is 40 feet thick, and underneath it there is a bed of clay, with rootlets, quite comparable to the underclay which is found beneath almost every bed of coal in the British and other coal-fields of the Carboniferous epoch. The Miocene rocks of Switzerland are familiar to all geologists who have traversed the country between the Jura and the Alps. Sometimes they are soft and incoherent, sometimes formed of sandstones and sometimes of conglomerates, as on the Rigi. They chiefly consist of fresh-water lacustrine strata, with some minor marine interstratifications which mark the influx of the sea during occasional partial submergences of portions of the area. These fresh-water strata, of great extent and thickness, contain beds of lignite, and are remarkable for the relics of numerous trees and other plants, which have been described by

Professor Heer, of Zurich, with his accustomed skill.

The Miocene fresh-water strata of the Sewalik Hills in India are well known to most students of geology, and I have already stated that they bear the same relation to the more ancient Himalayan mountains than the Miocene strata of Switzerland and the North of Italy do to the pre-existing range of the Alps. In fact, it may be safely inferred that something far more than the rudiments of our present continents existed long before Miocene times, and this accounts for the large areas on those continents which are occupied by Miocene fresh-water strata. With the marine formations of Miocene age this address is in no way concerned, nor is it essential to my argument to deal with those later tertiary phenomena which, in their upper stages, so easily merge into the existing state of the world.

Glacial Phenomena.

I now come to the last special subject for discussion in this address, viz., the Recurrence of Glacial Epochs, a subject still considered by many to be heretical, and which was generally looked upon as an absurd crochet when, in 1855, I first described to the Geological Society boulder-beds containing ice-scratched stones, and erratic blocks in the Permian strata of England. The same idea I afterwards applied to some of the Old Red Sandstone conglomerates, and of late years it has become so familiar that the effects of glaciers have at length been noted by geologists from older Palæozoic epochs down to

the present day. In the middle of last July I received a letter from Prof. Geikie, in which he informed me that he had discovered mammillated moutonnée surfaces of Laurentian rocks, passing underneath the Cambrian sandstones of the north-west of Scotland, at intervals all the way from Cape Wrath to Loch Torridon, for a distance of about 90 miles. The mammillated rocks are, says Prof. Geikie, "as well rounded off as any recent *roche moutonnée*," and "in one place these bosses are covered by a huge angular breccia of this old gneiss (Laurentian) with blocks sometimes five or six feet long." This breccia, where it occurs, forms the base of the Cambrian strata of Sutherland, Ross, and Cromarty, and while the higher strata are always well stratified, where they approach the underlying Laurentian gneiss, "they become pebbly, passing into coarse unstratified agglomerates or boulder-beds." In the Gairloch district, "it is utterly unstratified, the angular fragments standing on end and at all angles," just as they do in many modern moraine mounds wherever large glaciers are found. The general subject of Palæozoic glaciers has long been familiar to me, and this account of more ancient glaciers of Cambrian age is peculiarly acceptable.

The next sign of ice in Britain is found in the Lower Silurian rocks of Wigtonshire and Ayrshire. In the year 1865 Mr. John Carrick Moore took me to see the Lower Silurian graptolitic rocks at Corswall Point in Wigtonshire, in which great blocks of gneiss, granite, &c., are imbedded, and in

the same year many similar erratic blocks were pointed out to me by Mr. James Geikie in the Silurian strata of Carrick in Ayrshire. One of the blocks at Corswall, as measured by myself, is 9 ft. in length, and the rest are of all sizes, from an inch or two up to several feet in diameter. There is no gneiss or granite in this region nearer than those of Kirkcudbrightshire and Arran, and these are of later geological date than the strata amid which the erratic blocks are imbedded. It is, therefore, not improbable that they may have been derived from some high land formed of Laurentian rocks, of which the outer Hebrides and parts of the mainland of Scotland form surviving portions. If so, then I can conceive of no agent capable of transporting large boulders and dropping them into the Lower Silurian mud of the seas of the time than icebergs or other floating ice, and the same view with regard to the neighbouring boulder-beds of Ayrshire is held by Mr. James Geikie. If, however, anyone will point out any other natural cause still in action by which such results are at present brought about, I should be very glad to hear of it. I must now turn to India for further evidence of the action of Palæozoic ice.

In the Himalayas of Pangi, S.E. of Kashmir, according to Medlicott and Blanford, "old slates, supposed to be Silurian, contain boulders in great numbers," which they believe to be of glacial origin. Another case is mentioned as occurring in "transition beds of unknown relations," but in another passage they are

stated to be "very ancient, but no idea can be formed of their geological position." The underlying rocks are marked by distinct glacial striations. The next case of glacial boulder-beds with which I am acquainted is found in Scotland, and in some places in the north of England, where they contain what seem to be indistinctly ice-scratched stones. I first observed these rocks on the Lammermuir Hills, south of Dunbar, lying unconformably on Lower Silurian strata, and soon inferred them to be of glacial origin, a circumstance that was subsequently confirmed by my colleagues, Professor and Mr. James Geikie, and is now familiar to other officers of the Geological Survey of Scotland.

I know of no boulder formations in the Carboniferous series, but they are well known as occurring on a large scale in the Permian brecciated conglomerates, where they consist "of pebbles and large blocks of stone, generally angular, imbedded in a marly paste . . . the fragments have mostly travelled from a distance, apparently from the borders of Wales, and some of them are three feet in diameter." Some of the stones are as well scratched as those found in modern moraines or in the ordinary boulder-clay of what is commonly called the Glacial epoch.

In 1855 the old idea was still not unprevalent that during the Permian epoch, and for long after, the globe had not cooled sufficiently to allow of the climates of the external world being universally affected by the constant radiation of heat from its interior. For a

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long time, however, this idea has almost entirely vanished, and now, in Britain at all events, it is little, if at all, attended to, and other glacial episodes in the history of the world have continued to be brought forward, and are no longer looked upon as mere ill-judged conjectures. The same kind of brecciated boulder-beds that are found in our Permian strata occur in the Rothliegende of Germany, which I have visited in several places, and I believe them to have had a like glacial origin. Mr. G. W. Stow, of the Orange Free State, has of late years given most elaborate accounts of similar Permian boulder-beds in South Africa. There, great masses of moraine matter not only contain ice-scratched stones, but on the banks of rivers where the Permian rock has been removed by aqueous denudation, the underlying rocks, well rounded and mammillated, are covered by deeply incised glacier-grooves pointing in a direction which at length leads the observer to the pre-Permian mountains from whence the stones were derived that formed these ancient moraines. Messrs. Blanford and Medlicott have also given in "The Geology of India" an account of boulder-beds in what they believe to be Parmian strata, in which they compare with those described by me in England many years before. There the Godwana group of the Talchir strata contains numerous boulders, many of them 6ft. in diameter, and "in one instance some of the blocks were found to be polished and striated, and the underlying Vindhyan rock was similarly marked. The

authors also correlate these glacial phenomena with those found in similar deposits in South Africa, discovered and described by Mr. Stow.

In the Olive group of the salt range, described by the same authors, there is a curious resemblance between a certain conglomerate "and that of the Talchir group of the Godwana system." This "Olive conglomerate" belongs to the Cretaceous series, and contains ice-transported erratic boulders derived from unknown rocks, one of which, of red granite, "is polished and striated on three faces in so characteristic a manner that very little doubt can exist of its having been transported by ice." One block of red granite at the Mayo Salt Mines of Khewra "is 7ft. high and 19ft. in circumference."

In the "Transition beds" of the same authors, which are supposed to be of Upper Cretaceous age, there also are boulder-beds with erratic blocks of great size. I know of no evidence of glacial phenomena in Eocene strata excepting the occurrence of huge masses of included gneiss in the strata known as Flysch, in Switzerland. On this question, however, Swiss geologists are by no means agreed, and I attach little or no importance to it as affording evidence of glaciocice. Neither do I know of any Miocene glacier-deposits excepting those in the north of Italy, near Turin, described by the late eminent geologist, Gastaldi, and which I saw under his guidance. These contain many large erratic boulders derived from the distant Alps, which, in my opinion, were then at least

as lofty or even higher than they are now, especially if we consider the immense amount of denudation which they underwent during Miocene, later Tertiary, and post-Tertiary times.

At a still later date there took place in the north of Europe and America what is usually misnamed "The Glacial Epoch," when a vast glacial mass covered all Scandinavia, and distributed its boulders across the north of Germany, as far south as the country around Leipzig, when Ireland also was shrouded in glacier ice, and when a great glacier covered the larger part of Britain and stretched southward, perhaps nearly as far as the Thames on the one side, and certainly covered the whole of Anglesea, and probably the whole, or nearly the whole, of South Wales. This was after the advent of man. Lastly, there is still a minor Glacial Epoch in progress on the large and almost unknown Antarctic continent, from the high land of which, in latitudes which partly lie as far north as 60° and 62° , a vast sheet of glacier ice of great thickness extends far out to sea and sends fleets of icebergs to the north, there to melt in warmer latitudes. If, in accordance with the theory of Mr. Croll, founded on astronomical data, a similar climate were transferred to the northern hemisphere, the whole of Scandinavia and the Baltic would apparently be covered with glacier ice, and the same would probably be the case with the Faroe Islands and great part of Siberia, while even the mountain tracts of Britain, under these conditions, might

again maintain their minor systems of glaciers.

Conclusions.

In opening this address, I began with the subject of the oldest metamorphic rocks that I have seen—the Laurentian strata. It is evident to every person who thinks on the subject that their deposition took place far from the beginning of recognised geological time. For there must have been older rocks by the degradation of which they were formed. And if, as some American geologists affirm, there are on that continent metamorphic rocks of more ancient dates than the Laurentian strata, there must have been rocks more ancient still to afford materials for the deposition of these pre-Laurentian strata. Starting with the Laurentian rocks, I have shown that the phenomena of metamorphism of strata have been continued from that date all through the later formations, or groups of formations down to and including part of the Eocene strata in some parts of the world. In like manner I have shown that ordinary volcanic rocks have been rejected in Silurian, Devonian, Carboniferous, Jurassic, Cretaceo-oolitic, Cretaceous, Eocene, Miocene, and Pliocene times; and from all that I have seen or read of these ancient volcanoes, I have no reason to believe that volcanic forces played a more important part in any period of geological time than they do in this our modern epoch. So, also, mountain chains existed before the deposition of the Silurian rocks, others of later date before the Old Red Sandstone

strata were formed, and the chain of the Ural before the deposition of the Permian beds.

According to Darwin, after various oscillations of level, the Cordillera underwent its chief upheaval after the Cretaceous epoch, and all geologists know that the Alps, Pyrenees, Carpathians, the Himalayas, and other mountain-chains (which I have named) underwent what seems to have been their chief great upheaval after the deposition of the Eocene strata, while some of them were again lifted up several thousands of feet after the close of the Miocene epoch. The deposition of salts from aqueous solutions in inland lakes and lagoons appears to have taken place through all time — through Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Eocene, Miocene, and Pliocene epochs—and it is going on now. In like manner fresh water and estuarine conditions are found now in one region, now in another, throughout all the formations or groups of formations possibly from Silurian times onward; and glacial phenomena, so far from being confined to what was and is generally still termed *the Glacial epoch*, are now boldly declared, by independent witnesses of known high reputation, to begin with the Cambrian epoch, and to have occurred somewhere, at intervals, in various formations, from almost the earliest Palaeozoic times down to our last post-Pliocene "Glacial epoch."

If the nebular hypothesis of astronomers be true (and I know of no reason why it should be

doubted), the earth was at one time in a purely gaseous state, and afterwards in a fluid condition, attended by intense heat. By-and-by consolidation, due to partial cooling, took place on the surface, and as radiation of heat went on, the outer shell thickened. Radiation still going on, the interior fluid matter decreased in bulk, and, by force of gravitation, the outer shell, drawn towards the interior, gave way, and, in parts, got crinkled up, and this, according to cosmogonists, was the origin of the earliest mountain chains.

I make no objection to the hypothesis, which, to say the least, seems to be the best that can be offered, and looks highly probable. But, assuming that it is true, these hypothetical events took place so long before authentic geological history began, as written in the rocks, that the earliest of the physical events to which I have drawn your attention in this address was, to all human apprehension of time, so enormously removed from these early assumed cosmical phenomena, that they appear to me to have been of comparatively quite modern occurrence, and to indicate that from the Laurentian epoch down to the present day, all the physical events in the history of the earth have varied neither in kind nor in intensity from those of which we now have experience. Perhaps many of our British geologists hold similar opinions, but, if it be so, it may not be altogether useless to have considered the various subjects separately on which I depend to prove the point I had in view.

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